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POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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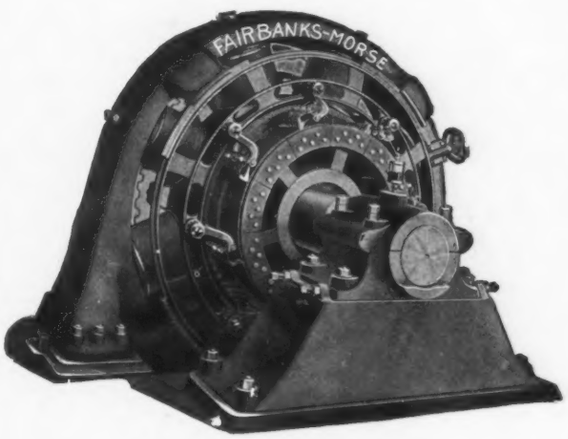

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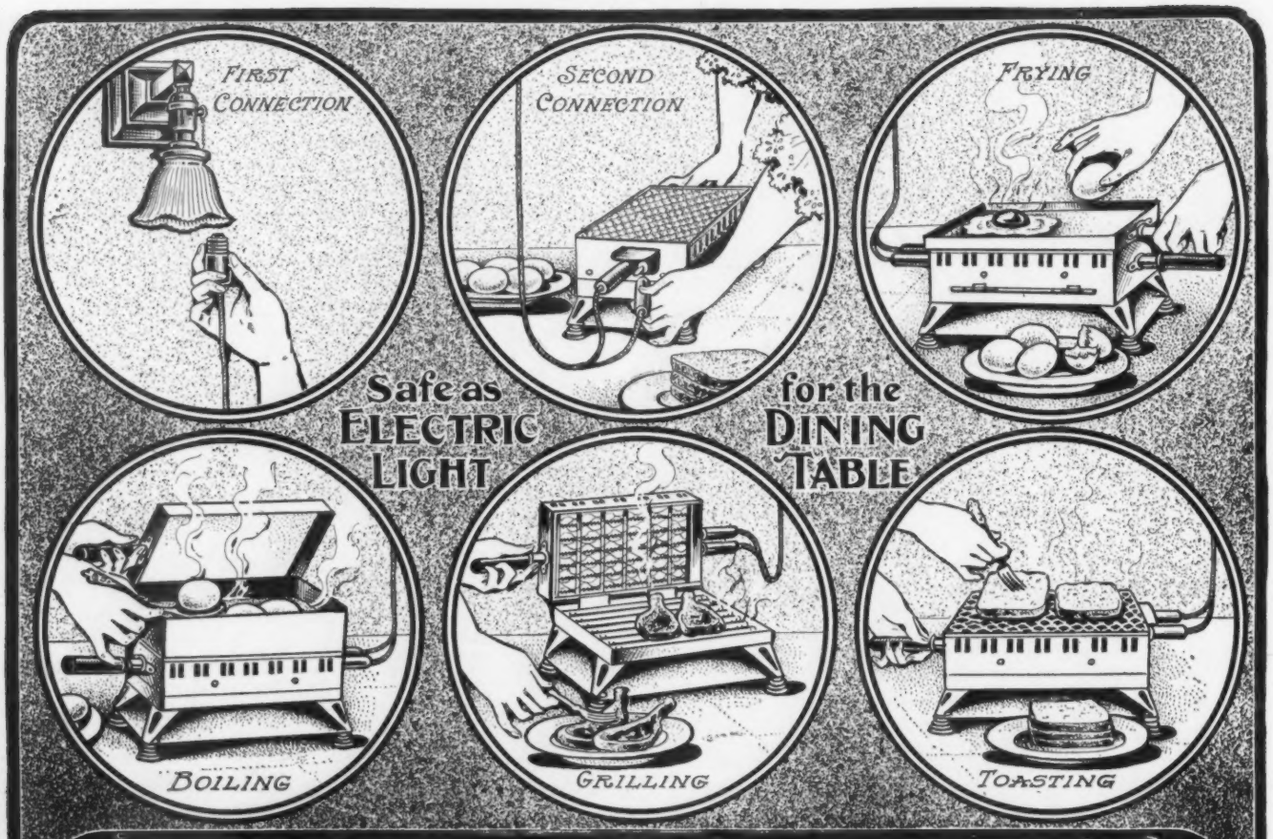

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VOLUME XXVIII | SAN FRANCISCO, MAY 25, 1912 | NUMBER 21

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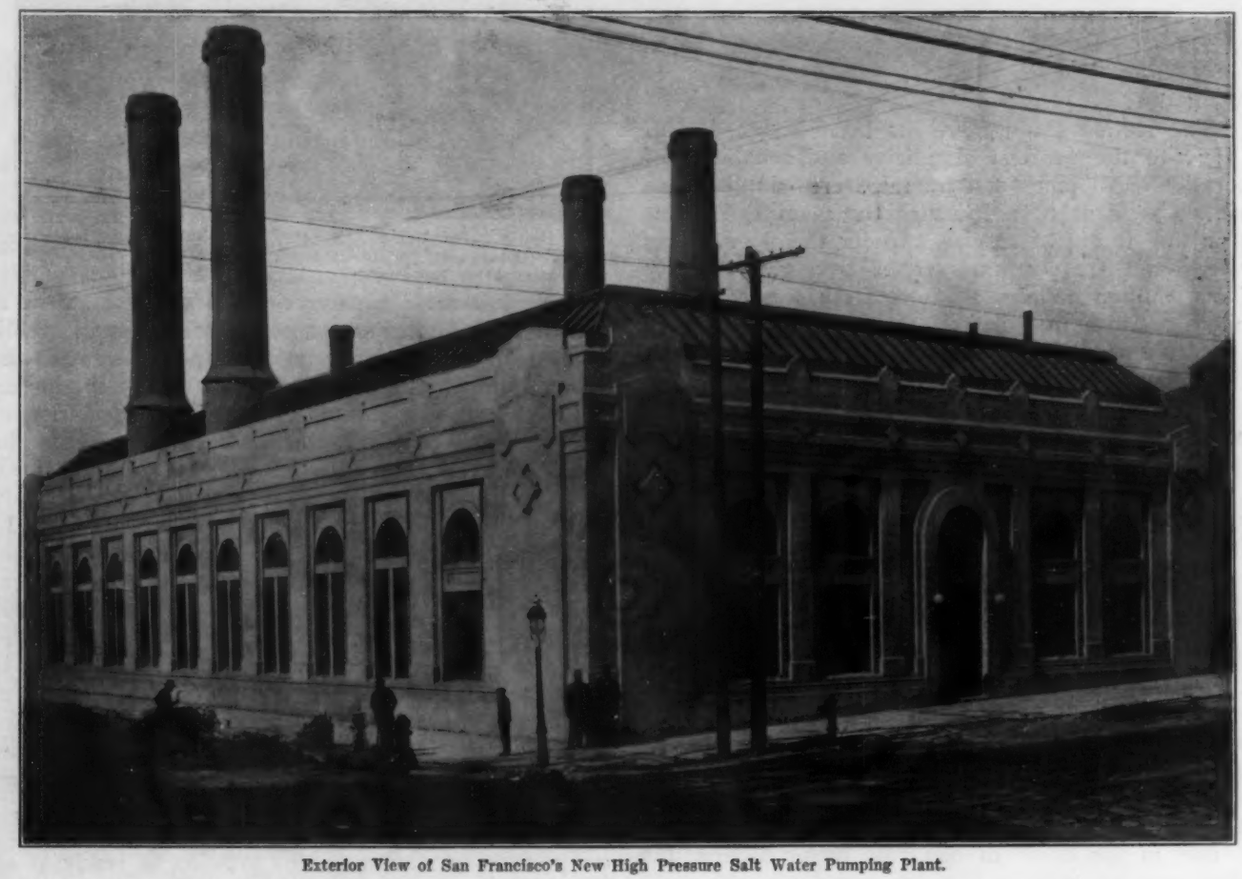
SAN FRANCISCO'S HIGH PRESSURE WATER SYSTEM

BY ROBERT SIBLEY.

On Saturday, May 4th, a notable gathering of Western engineers witnessed the acceptance test of pumping station No. 1 of the high pressure salt water system of San Francisco. The catastrophe of 1906 in which the business section of the Western metropolis was swept from the face of the earth, largely due to the fact that water could not be obtained to fight the fires, led serious-minded men to consider ways and means of insurance against the possible recurrence of this event.



Exterior View of San Francisco's New High Pressure Salt Water Pumping Plant.

A reservoir has been constructed upon Twin Peaks which delivers fresh water at a 700 ft. pressure to any portion of the city. In case this reservoir should be emptied, an auxiliary high pressure system has been installed to meet the emergency by pumping salt water from San Francisco Bay into the city mains. These mains constitute a network of cross-connections throughout the business district of the city and it is believed to be next to impossible that all the various channels could ever be shattered at one time.

Pumping station No. 1, which has just been completed at a cost of $500,000, is located on a lot fronting on Townsend street, and extending from Second

to Stanford street. The station is housed in a Class A building, 160 x 85 ft., facing on Second, Townsend and Stanford streets and in the rear is a lane 15 ft. wide.

The entire excavation for the building is in solid rock. A channel has been cut to the waters of the Bay so that the salt water supply is immediately below the pumps in the power house. Great care was taken in excavating the lower levels in order not to disturb the bed of the soil or rock in the upper levels and in cases where the material was removed at a lower depth than that given in the specifications, the filling and levelling up was done with concrete.

After the completion of the building, the back filling was accomplished with sand and fine gravel in layers not more than 2 ft. in depth, each layer being thoroughly watered down with a hose and rammed solid. Sub-drains of six-inch iron pipe not less than ¾ in. thick were laid with loose joints and covered in such a manner as to exclude loose earth or sediment but to allow free passage of water.

The steel frame of the building is one of the heaviest which has been constructed in San Francisco and contains 500 tons of steel. It has been designed to withstand the most severe stress. The walls and roof of the building are of reinforced concrete. No expense has been spared to make this building absolutely fireproof. All of the windows are wired glass in metal frames and, in addition, rolling steel shutters are fitted at all openings.

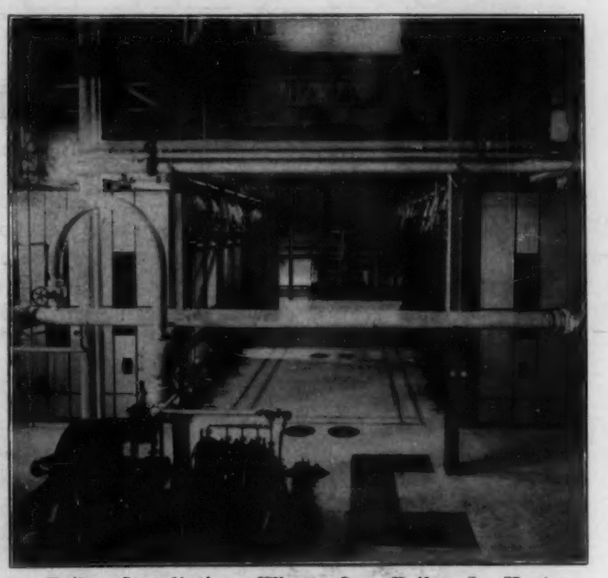
The station throughout has been designed with a view to the greatest simplicity and reliability of operation. All pipes and pumps are in duplicate so that an accident to no part of the plant can result in putting it out of service. Under the floor of the boiler room are six water tanks having a capacity of one million gallons, to store fresh water for the boilers and in Stanford street are five oil tanks having a capacity of 2000 bbls. of fuel oil, so that sufficient oil and fresh water may be stored in the station to permit of its being operated at full capacity for three days continuously without receiving additional supplies of water or oil.

The pumps are arranged to store salt water from the bay through a reinforced concrete tunnel 5 ft. in diameter and 1100 ft. long, extending down Townsend street and through the sea walls. Two pipes twenty inches in diameter are connected to the pumps, one of these leads up Second street to Market street and thence to Sansome and to the pumping station No. 2 at Fort Mason, the other leads up Townsend, Stanford, Brannan, Seventh, Harrison, Ninth, Folsom and Eleventh street and thence to Twin Peaks reservoir and thence to pumping station No. 2. Either of these pipes is sufficiently large to carry the entire discharge of the station and distribute it where it may be needed, so that in the event of one pipe being broken, the other may be used.

Boilers.

Babcock & Wilcox boilers are installed in the pumping station. Boilers are arranged in four batteries of two each, each battery being enclosed by steel plate casings with magnesia covering between the casing and the brick work on the sides and back. The boilers themselves are of the standard type with two drums, 18 ft. 4½ in. long and 42 in. in diameter; 191 four-inch tubes 16 ft. long, arranged 16 ft. wide and 12 ft. high with vertical forged headers. The boilers contain approximately 3500 sq. ft. of heating surface and are rated at 350 h.p each. The burners are of the Hammell type, two in each boiler. Each set of batteries which constitute two boilers are served with independent reinforced concrete smoke stacks as shown in the illustration.

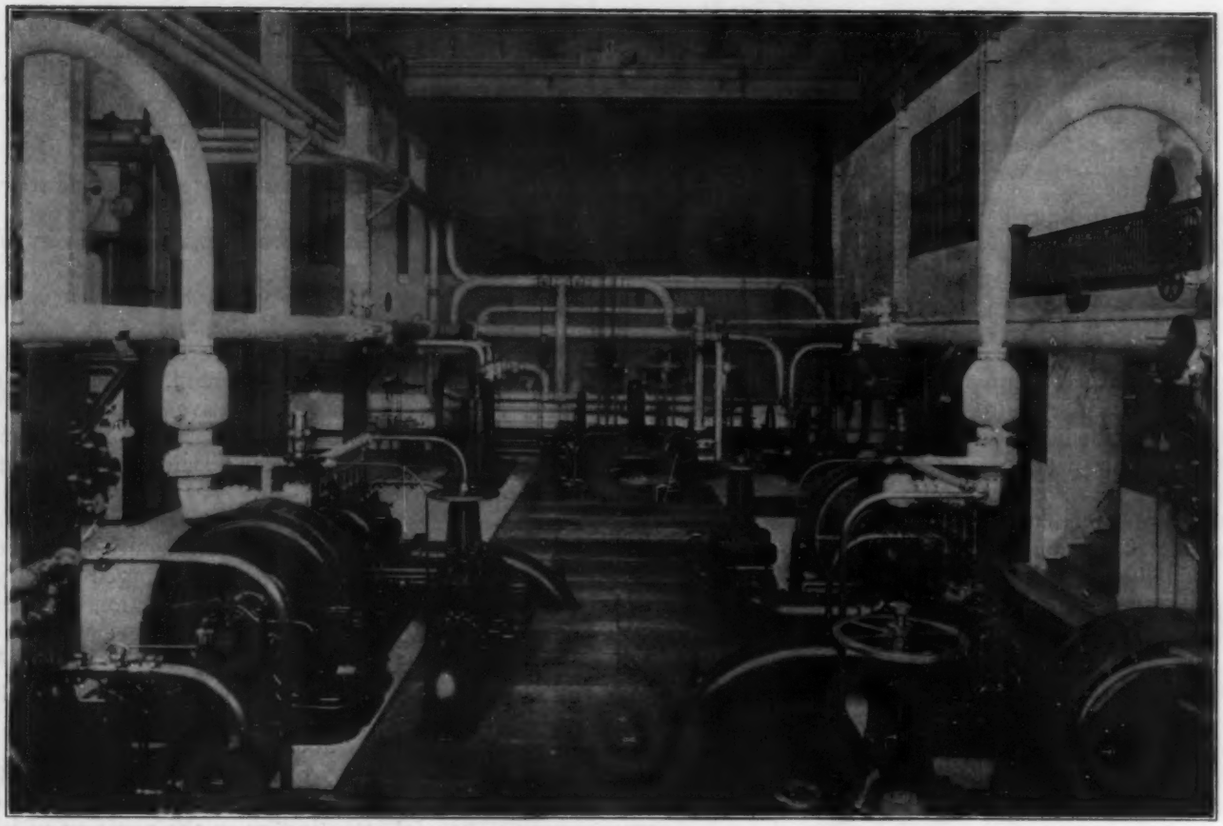
This station, which is maintained and kept in readiness for emergency conditions, is of interest in consideration of the guarantees demanded from the builders. The boilers were guaranteed to be operated



Boiler Installation, Where One Boiler Is Kept Eternally In Readiness for Instant Service.

at their full rated capacity—evaporating the equivalent of 7075 lbs. of water per hour from and at 212 degrees F. at an efficiency of 79 per cent after deducting from the total steam generated by the boiler, the steam required by oil furnaces in atomization of the oil. The boilers were also guaranteed to be capable of being forced to an evaporization of 21,000 lbs. of water from and at 212 degrees F. continuously without injury to the boiler or any part thereof. In regard to the rapidity to be attained in raising steam it was also guaranteed that any boiler should be capable of raising steam to full pressure of 200 lbs. per sq. in. in thirty minutes when the boiler was filled with water to the heighth of two inches in the water glass, with feed water at a temperature of 70 degrees F., it being understood that the steam for atomizing the oil in the furnaces be furnished from another boiler. The feat was of course to be performed without injury to the boiler or any part of it.

The stand-by loss is of interest. In maintaining an emergency station of this type to be ready at all times, full boiler pressure of 200 lbs. per sq. in. must be kept up in one of the boilers at all times. It was agreed that the oil necessary to perform this function continuously should not exceed 5 per cent of the fuel oil necessary to operate the boiler at its rated capacity. In performing its steam generating function each boiler was also guaranteed, whether operated at rated horsepower or at 75 per cent overload, to generate the steam with a moisture condition not to exceed



High Pressure Turbine Units.

½ of 1 per cent. A full and exhaustive test, the results of which will appear in an early meeting of one of the national engineering societies, performed by Professor Jos. N. Le Conte of the University of California demonstrated that the installation of the boilers had met every condition of guarantee.

Steam Turbines and Pumps.

Four pumping sets or units are installed in this station each consisting of a four stage horizontal turbine pump on the same bed plate and directly connected to a horizontal steam turbine. The pumps have been furnished by Byron Jackson Iron Works of San Francisco. Each pump has a capacity of 2700 gallons per minute and a pressure of 300 pounds per sq. in. when operated at a speed of 1800 r.p.m. The steam turbines are of the Curtis type, manufactured by the General Electric Company. These turbines operate non-condensing under a pressure of 150 lbs. per sq. in. and have a rated capacity of 750 h.p.

In addition to performing the output rating above mentioned, the builders guaranteed that the duty of each pump would not be less than 38,000,000 foot pounds of work performed per one million B.t.u. supplied to the steam turbine, the temperature of feed water being assumed to be 200 degrees F.

After a careful test of the pumps, which test was conducted at the power house of the Oakland Gas, Light & Heat Company, First and Grove streets, Oakland, it was found that all four pumps gave more than the necessary 2700 gallons per minute of salt water discharge and more than the necessary 300 pounds pressure per sq. in. at the discharge nozzle, when working under more than 15 ft. suction lift. The duty of all the pumping units slightly exceeded the required 38,000,000 ft. pounds of work per one million units consumed by the steam turbine. It was also found that the pumps are capable of carrying much higher suction heads than can be carried by the fire boat units installed in San Francisco, the discharge of 1600 gallons per minute under 300 lb. pressure being maintained with a 22-inch vacuum at the suction. The mechanical operation of the units was found perfect throughout the test, there being no heating nor excessive vibration. In fact they operated throughout the entire test with little attention.

The steam driven dynamo for furnishing electric light to the building and the necessary feed water heaters, fuel oil pumps and other accessories complete the installation.

The interior appearance of the power house is of neat and substantial design. In fact it is doubtful if any power installation on the Coast presents the trim and finish observed here, even to the tile flooring. Minute care in design and constructive detail is shown on every hand.

The acceptance test was witnessed by the engineers of the Fire-underwriters, Chamber of Commerce, and the Mission Promotion Society and pronounced a success by them. The station is now in full service and the fires are being kept under one boiler continuously, so that the station is, at all times, ready to furnish fire protection to property in San Francisco and stands as a sentinel, ready at all times to perform its gigantic protective function.

ELEMENTS OF HYDRAULIC ENGINEERING

THE DEVELOPMENT OF THE TANGENTIAL WHEEL.

BY GEORGE J. HENRY.

In the early days of this western country when man sought fame and gold in the mines of California, it took six months to get to the promised land from "Home" and when one landed down at the old wharf on Montgomery and Clay streets with but little else than a pioneer spirit of determination to conquer fortune from the soil, a strong right arm and a sturdy physique were counted the best assets. He could not bring machinery with him for an undiscovered mine, even if such had been attainable in the eastern markets at that period. He could not get it in the west, for everyone was in some more profitable occupation, and at that time, things were too unstable to maintain anything akin to machine works.

Everything that the miner needed had to be packed long distances at enormous expense—an egg sold for one dollar at the old Oregon house on the road from Marysville to Nevada, and although eggs have come down, the old Oregon House has not. Those were the days when the life streams of these western shores ran with the rugged romance of Bret Harte, when the pathos of man's strife with nature was lost sight of in the glowing warmth of his golden heart, when the snows of the Sierras crowned many a grave of hopes and when man forged hard and long for a paltry bit of gold.

During this period of tense action, the discovery and proving of many mining prospects created a demand for power. At probably no period had labor commanded a higher price—laborers in San Francisco, could not be found at less than $15 to $20 a day, and mechanics in every trade were asking fabulous prices. Every man was working for himself, and thus the panning out of gold where found in paying quantities became very arduous and expensive and its cheaper extraction became a necessity. Water was plentiful in the Sierras, especially on their western slopes where many ditch companies developed systems of water supply to the various mines on the Mother Lode. Iater this water proved a valuable asset and today it is frequently found to be the nucleus for a considerable irrigation system feeding the arable lands in the Sacramento and San Joaquin Valleys which parallel the great range of the Sierras, provided with nature's reservoirs of snow.

This water supply was essential to the working of the mines, and as the ditch was often at a high elevation, the water used for the mine was dropped down to the mill. Considerable energy was thus going to waste unless put to some use by the ingenious miner. What could be more natural than that this necessity for water to wash the gold and work the property, combined with the available water power at the door as opposed to the distant source of supply of water power machinery, should have put to a severe test the inventive genius of the miner. The hurdy-gurdy was the result. This was the forerunner of the modern tangential wheel, and for many years or until the value of water in some of the ditch systems became so great as to practically force the invention of improved and more efficient water wheels it was extensively used. The hurdy-gurdy wheel is now obsolete and has but an historic interest. For years, however, it supplied the needs of the miners of the Sierras in a way, no other then known piece of apparatus possibly could. It was usually made on the ground, of wood and supplied through the most primative of pipe lines and giants, as nozzles were usually called, on account of the name of the most popular nozzle for placer mining then in use.

The vanes (corresponding to buckets on a modern tangential wheel) were at first only flat paddles, and the water from the "Giant" impinged directly on the flat surface, spattering in all directions and transforming but 30 or 35 per cent of the energy in the water into useful energy on the wheel shaft. At a little later date, in the sixties, this wheel was equipped with vanes having a central splitter to divide the stream without shock on entering the vane. This was certainly a great improvement over the older form, but nearly all were still made of wood, and seldom was any careful attention given the question of wheel diameter or speed, and its essential relationship to the head or spouting velocity. The increasing demands for larger amounts of power as the mines developed, and its cost as the price of water supplied by the ditch company advanced, brought again in the early seventies a still further improvement of the greatest importance by Lester A. Pelton. Mr. Pelton was a mill wright well known in the mining section of Nevada County who built many water wheels in the old foundries established in the early days in the mining towns. His early labors showed by practical experiment the now well known advantage to be derived from the tangential water wheel bucket having a central splitter or wedge on which the water entered without shock and passed over the curved surfaces with least resistance gradually giving up its velocity until discharged at as nearly zero velocity from the sides of the bucket cavities as could be practically attained. The patents taken out by Mr. Pelton in 1882 and 1888, as shown in Figs. 20 and 21, are clearly descriptive of the fundamental principles of the wheel so well known the world over today and, although long since expired, they embody the essential elements of every successful tangential wheel.

The early wheels were constructed of wood with cast iron cups bolted or lag screwed on the rim with a circular jet of water from a nozzle impinging on the splitter of the buckets. It seems likely that about the same time, as is frequently the case where the necessity of an invention is so universal, that several others working independently but along the same lines reached the some general design of water wheel bucket, but it is certain that no one else built as many wheels or devoted the time and attention to the attainment of

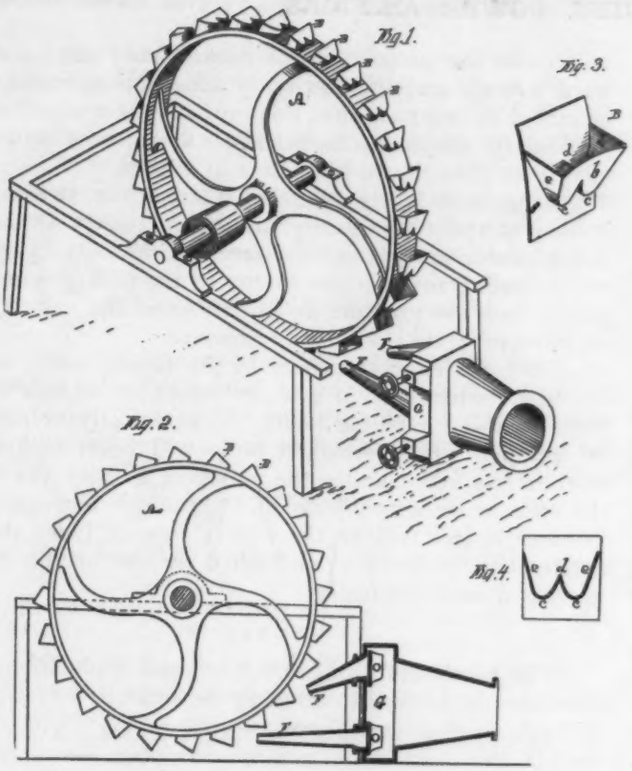


Fig. 20. First Pelton Patent.

best efficiency. Shortly after the wheel had begun to attain local fame, the Knight wheel was further improved, Mr. Knight, of Sutter Creek, Cal., made great claims for his wheel shown in Fig. 22, and undoubtedly obtained excellent results. In a comparative test of the two types at the Empire Mine in Grass Valley, however, the Knight wheel did not show up as well as its competitor, and this test thereby established on a firm basis the reputation of the Pelton. Mr. L. A. Pelton in 1888 sold out to A. P. Brayton of the Pacific Iron Works and immediately thereafter the Pelton Water Wheel Company was formed to manufacture this wheel in order to meet a constantly growing demand. Its extreme simplicity, its reliability for continuous service, its ability to utilize high heads with excellent efficiency made it a most attractive prime mover. It was most readily adapted to use on a horizontal shaft, occupied very little space, and at the speeds of the then most popular mining machinery it could be most readily directly connected.

For conducting the water to the wheels, wood pipe was sometimes used although most frequently riveted sheet iron. The high pressures made use of with perfect success in this pipe, which was made up of thin plates, almost seem to defy our well known laws of mechanics. The practice today, however, is to use safety factors much higher than were then generally considered satisfactory.

Automatic speed regulation was not attempted and in fact was scarcely necessary since the cam shaft and concentrators, while requiring a constant speed, offered a constant load. Hence, if a special wheel was devoted to each machine, the most perfect speed control was effected by the occasional manipulation of the main gate valve.

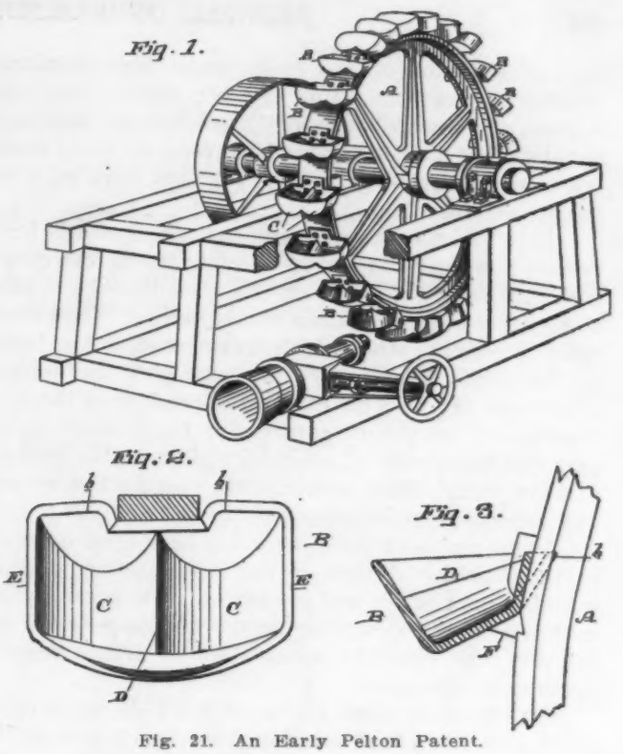


Fig. 21. An Early Pelton Patent.

On the other machinery around the mine speed variation did not affect the results. The average mine probably employed 4 to 8 wheels, although at times

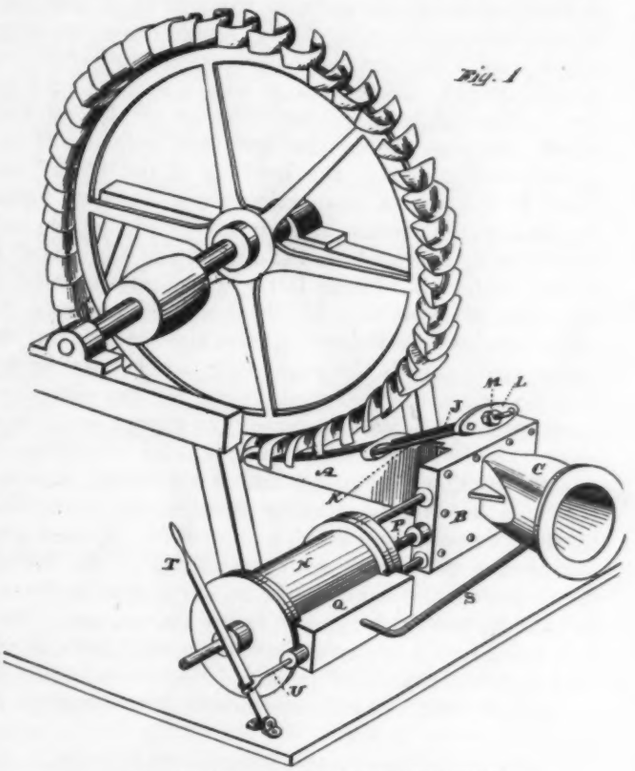


Fig. 22. The Knight Tangential Wheel.

numbering over 20. Without doubt these wheels were the most effective and satisfactory power known for mining. In the early days they were made in sizes up to about 7 ft. and later during the nineties up as

high as 32 ft. to get slow speed under high heads for driving compressors. But in more recent years the tendency is toward units of large capacity and high speed so that diameters have been reduced while buckets, shafts, nozzles, gates and bearings have all been greatly increased.

It is a fact worthy of notice that the wheels built twenty-five years ago gave in many cases extremely high efficiencies. Improvements since then have been along other lines more than bucket design. The patent office records are strewn with inventive efforts on buckets but aside from a very few examples the designs of buckets patented have been the product of the misconceptions of the inventors and but seldom based on a real knowledge of what takes place in the buckets of a tangential wheel and scarcely ever backed by any real experimental investigation.

Some really valuable work has been done however in the machine design of the associated apparatus, especially in nozzles and governors. The great strains involved in the operating parts of a large unit call for the most careful consideration to secure reliable continuous operation.

The buckets must, of course, have the right curvature to receive the water without shock and at the spouting velocity from the nozzle; to take the greatest possible velocity out of the moving water jet during its passage through the bucket with a minimum loss in friction on the bucket surface. This result is attained with an efficiency of from 80 to 92 per cent in well designed wheels. Other losses, however, occur which tend to reduce the wheel output and therefore the efficiency of the apparatus as a whole. These are the mechanical friction, the windage of the rotating wheel, the loss due to the discharge velocity of the water when it leaves the buckets of the wheel, the losses in the nozzle, connecting pipes and gate valve, the loss in the stream after it leaves the nozzle and before being received on the buckets of the wheel is further reduced. These latter losses are greater in any form of regulating nozzle than in a properly designed simple nozzle for the same size stream, but the facility with which the regulating nozzle may be adjusted during operation makes its all day efficiency much superior if water economy at partial loads is of value. If however, the adjustment of a regulating nozzle, whether by hand or automatic device, does not result in holding in suitable storage the water that would otherwise be wasted, so that it can be used later during say peak load or if variations in the stream flow which make it necessary to correspondingly curtail the output in the power house do not occur, then it is much better to use a simple non-adjustable nozzle with a counterbalanced stream deflector and to allow a constant flow through the nozzle whether it is all used for power or not.

It is a noteworthy fact that the Pacific Coast and particularly California has led the world in tangential water wheel development. European practice in these wheels is now following along with a lag factor of several years. The high efficiencies recently reported by European makers are being obtained with bucket shapes that have been in use in this country for a considerable time and long ago their superiority has been demonstrated.

As to the proportions of buckets of tangential water wheels and the theory of their action, it may be stated at this time that this type of water wheel is particularly adapted to higher heads and smaller water quantities than the turbine class of wheels.

Tangential wheels employ a stream or streams issuing at spouting velocity, the entire energy of the falling water being kinetic, whereas turbines, as generally used, transform the energy of the falling water partly from the pressure and partly from the velocity or, more properly the velocity pressure.

To make clear the effect of the falling water on the buckets or vanes of a water wheel let us look at the formulae for falling bodies. The velocity or rate in feet per second which a body will be travelling after it has fallen under the action of gravity (as is the case in most problems of hydraulics) through a distance h feet will be the square root of twice the acceleration of gravity multiplied by the height, or expressed mathematically

$$v = \sqrt{2gh}$$

The acceleration of gravity is equal to 32.16 and therefore the above formula may be written

$$v = \sqrt{2gh} = \sqrt{2 \times 32.16\, h} = \sqrt{64.32\, h} = 8.025\sqrt{h} \quad \ldots (1)$$

This gives us at once the spouting velocity for any head. It must be borne in mind that h is the head acting at the point of issue and therefore if the water is delivered from a pipe line the head h is what is left after deducting the friction loss.

Example 1. What will be the spouting velocity under a surveyed head of 520 ft. when the friction loss is 30 ft? In this case we have $520 - 30 = 490$ ft. effective head and therefore

$$v = 8.025\sqrt{490} = 8.025 \times 22.14 = 177.67 \text{ ft. per second.}$$

It needs no demonstration to see that if the area of the stream be represented by a then the quantity that will issue from the nozzle will be

$$Q = a\,v = 8.025\, a\sqrt{h} \quad \ldots (2)$$

Example 2. What quantity in cubic feet per second will flow in a two-inch diameter circular stream issuing under an effective head of 490 ft?

d = diameter of stream in inches, then 2 inches circular stream has an area of $\dfrac{\frac{\pi d^2}{4}}{144} = a = \dfrac{3.1416}{144} = .0218$ sq. ft.

$$Q = a\,v = .0218 \times 177.67 = 3.87 \text{ cubic feet per second.}$$

The energy of a falling body may be represented by the weight of the body multiplied by the height it falls and as the weight of a cubic foot of water = 62.4 pounds we have the footpounds of energy represented by

$$62.4 \times Q \times h = 62.4\, Q \frac{v^2}{2g} = \text{ft. pounds} \quad \ldots (3)$$

and as there are 550 ft. pounds per second expended in producing work at the rate of one horsepower have theoretically

$$H.P._T = \frac{62.4\, Q \times h}{550} = \frac{62.4}{550} \times \frac{v^2}{64.32} \times Q \times h \quad \ldots (4)$$

and if the water wheel has an efficiency of μ then the horsepower from the wheel would be represented by

$$\text{H.P.} = \mu \frac{62.4}{550} Q \times h = .1134\, Q\, h\, \mu = .001763\, v^2\, Q\, h\, \mu \ldots (5)$$

Example 3. What horsepower should we expect from a wheel running at 80 per cent efficiency under 490 ft. effective head and using a 2 in. jet of water?

$$\text{H.P.} = .1134 \times 3.87 \times 490 \times \frac{80}{100} = 172$$

The pressure exerted by a column of water at rest may be determined by considering that 1 cubic ft. of water weighs 62.4 pounds. The weight of pressure on each square inch of the base will therefore be

$$\frac{62.4}{144} = .433 \text{ pounds.}$$

and for a height of column h ft. we would have

$$p = .43\, h \text{ or } h = \frac{p}{.43} = 2.33\, p \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Example 4. What will the pressure gauge indicate when the gate in example 1 is closed?

$520 \times .433 = 225.16$ pounds per sq. in. and when the gate is open and the effective head is 490 ft. then $490 \times .433 = 212.17$ pounds per sq. in.

To arrive at a clear understanding of velocity pressure, think of what happens when we hold a stick in a flowing stream. The water will crowd upon the upstream side, and the greater the velocity of the current the higher it will rise against the stick. The height to which it will rise is a measure of the velocity and therefore the head producing the velocity. If we eliminate losses, as would be approximately the case if we turned a jet of water upwards in a vacuum from the bottom of the pipe, we would then have all the kinetic energy of the falling water raising the same water quantity and therefore it would rise to the same height as that from which it fell namely, h.

If we were to register the force of the impulse we would find that the pressure against a frictionless surface was twice the static pressure as shown in Fig. 23.

Impulse = mass × velocity or $F = m\,v \ldots\ldots\ldots\ldots\ldots (7)$

which is one of the fundamental equations in mechanics.

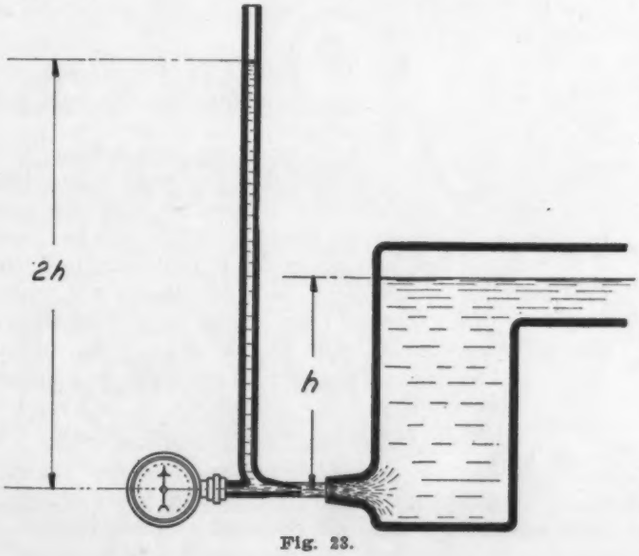


Fig. 23.

In the case of a jet of water the mass $= \dfrac{\text{weight}}{\text{gravity}}$

and therefore $\dfrac{62.4 \times a \times v}{g}$ = weight of water striking the unit surface in one second and therefore for an area of one sq. in. we have

$$\frac{62.4}{144} \times \frac{a\,v}{g}$$

and

$$F = \frac{62.4 \times a\,v}{144} \frac{v}{g} = \frac{2 \times 62.4}{144} \times \frac{a\,v^2}{2g} = \frac{124.8}{144} a\,h = .866\, h \ldots (8)$$

from which we see by comparing with equation (6) that the pressure due to the impulse is twice the hydrostatic pressure.

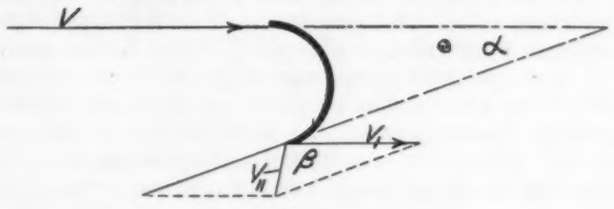


Fig. 24.

If instead of a plain surface we use a curved surface to receive the jet of water as shown in Fig. 24, then the force of impulse will tend to force the surface in the same direction and as the water curves over the return portion (that is $< 90°$) the re is a reactive force lost by the returning water equal to

$$\frac{w\, v_1 \cos \beta}{g} \text{ because } > o° \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

i.e. the return is not complete and therefore the reaction is equal to the impulse

$$\frac{w\, v_1 \cos \beta}{g}$$

Where W is the weight of water discharged by the bucket in one second. Combining the impulse and reactive component we then get

$$\frac{w}{g}(v - v_1) \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

as the impulse $+ \left(\dfrac{g}{w}(v - v_1) - \dfrac{g}{w}(v_1 \cos \beta)\right)$

$$F = \frac{w}{g}\left((v - v_1) + (v - v_1) - (v_{11} \cos \beta)\right)$$

If now $a = o$, then $v_1 = o$ and if $v_1 = \dfrac{v}{2}$

the condition approached in tangential wheels, then we have

$$\frac{w}{g}(v - v_1) + (v - v_1) - (v_{11} \cos \beta) = \frac{w\, v}{g} = \text{total impulse}$$

and by (8) this $= .866$ h.

which is twice the static pressure when the wheel pitch circle is running at 50 per cent of the water jet velocity.

By the same reasoning it will be seen that if the wheel be locked and full jet turned on the buckets the impulse + reaction, that is the total effort tending to move the bucket and therefore straining the bolts and balance of the structure will theoretically be

$$\frac{w}{g}(v + v_1) = \frac{2wv}{g} = 1.732\,h \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

which is twice the normal running impulse and four times the static pressure. On the other hand it is also seen that the impulse entirely disappears when $v_1 = v$ and the wheel would then be running at spouting velocity.

Due to the action of the jet alone the wheel can never attain spouting velocity but can only run at such a speed that there will be a sufficient impulse + reaction to overcome the actual load + the losses of friction and windage.

In practice the velocity of the pitch circle of the wheel is designed to run not at 50 per cent of the spouting velocity as determined from the gross head reduced by friction in pipe (H — f —h) but at about 47 to 49 per cent of the actual spouting velocity reduced by gate and nozzle and windage and bucket surface friction losses. In other words all the hydraulic losses that occur tend to reduce the velocity causing the impulse and reaction. This corresponds in most cases with 42 to 47 per cent of $v = \sqrt{2gh}$.

ERRATA NOTICE.

The Rotary Air Compressor.

In the discussion of the rotary air compressor, which appeared in these columns of March 23d, several errors were introduced and hence the following errata should be noted by those following this series of articles.

In the equation for power the mean effective pressure p, should be used. Thus,

$$p = \frac{p_1}{k v_1}\left[\left(\frac{p_2}{p_1}\right)^k - 1\right]$$

Hence

$$\text{Power} = \frac{p\,Q_1}{550}$$

in which Q_1 is the cu. ft. per sec. entering the impeller blades, and p the mean effective pressure.

Thus in the illustrative problem of the same issue we should compute the power as follows:

$p_1 = 14.7 \times 144 = 2{,}120$ lb. per sq. ft. $v_1 = 13$ cu. ft. per lb.
$p_2 = 69{,}650$ lb. per sq. ft.

Since $p_1 v_1^{1.41}$, we have: $2{,}120 \times (13.1)^{1.41} = 69{,}650 \times v_2^{1.41}$
$v_2 = 1.103$ cu. ft. per lb.

$$\therefore\ Q_1 = Q_2 \times \frac{13.1}{1.103} = \frac{1{,}000 \times 13.1}{1.103} = 11{,}875 \text{ cu. ft. at 14.7 lb. per sq. in.}$$

$$p = \frac{p_1}{k v_1}\left[\left(\frac{p_2}{p_1}\right)^k - 1\right] \text{ mean effective pressure.}$$

Substituting: $p = \frac{2{,}120 \times 1.41}{.41 \times 13.1}\left[\left(\frac{69{,}650}{2{,}120}\right)^{.291} - 1\right] = 982$ lb. per sq. ft.

$$\therefore\ Po = \frac{982 \times 11{,}875}{550 \times 60} = 353.0 \text{ Horsepower.}$$

Which is the total h.p. delivered to the shaft of the impeller.

In addition in the derivation of the several formulas in the article above referred to, the following errors occur, viz:

$\frac{p_2}{p_1} = (1 + k\frac{W}{p_1 V_1})$ ..... should be $\frac{I}{k}$ exponent

$W = e\,N = \frac{u_2^2}{1\,g}$ should be $W = \frac{e\,N\,u_2^2}{g}$

PROFIT-MAKING IN ELECTRICAL CONTRACTING.[1]

BY LOUIS LEVY.

In figuring contract work—that is in estimating from a plan and specification as submitted by architects, we use a form printed for the particular purpose. On one side of the sheet is room for itemizing each floor of the job and, if it is an irregular job, there is space for itemizing each room with places for the number of outlets—whether center or bracket, also whether single, 2, 4, lights, etc. On the same line as the outlet we have space for the plugs, switches, circuit, the number of feet of conduit necessary to complete that particular outlet, and also the wire and a place for the labor necessary to install the particular material we have listed as necessary for the outlets marked. When we get through taking off a job, we have measured up every piece of pipe in the most particular way, and taken off our labor in so close a manner that we feel we are not guessing but actually figuring labor. We then add the quantities we have listed and this gives us the number of feet of conduit, wire, hours of labor, and all other information.

On the reverse side of the sheet we have columns for quantities—a printed list of material and column for price on each and in total—also a separate column for the finish of the job. We get our total quantities from the details listed and in figuring our cost we use prevailing prices at which we can buy material.

We have used in past years—when we were doing bush and knob work—a method of averages at so much per outlet, but on conduit work, we have not done enough to warrant us to try this method, unless we are not particular as to whether we get the job.

After the amount of cost is computed, the percentage we expect to get as profit is added and a bid is made out on printed forms for that purpose. At the present time we are adding 50 per cent of our cost to arrive at the amount we should bid on the job. The copy of the bid and the estimate itself are then filed in numbered envelopes. We use a 4 x 6 filing cabinet to index these envelopes—use the locations as the main index and cross-index under architects, owners and contractors headings. Our files now are as high as 4300, each number representing something in the way of overhead expense without any guarantee of return for the investment.

We do not attempt, with very few exceptions, to follow up an estimate—believing that if we are low we will generally get the job.

When we do get a contract, we open a folder in a filing cabinet, which is legal size, and head it by whatever letter of the alphabet it may be, and the next number; as, for instance, the Coliseum would be C and if 97 was the last number under C that was used, the new contract would be C-98. All papers are transferred to this folder—a copy of the inspection report, also all papers which refer to the contract, as well as plans, and we make a practice of getting a set of plans and specifications of every job we do, so that we can lay our hand on any plan asked of us for possibly five years back.

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[1] A paper read before San Francisco Local No. 1, California State Association of Electrical Contractors.

At the time of opening the contract we enter the number in a small book, in which is kept the inspection number, a record of labor and material tag numbers. These tag numbers are entered in this book before an order for material is filled and we have by this means an index to all material charges which should be in the file when the contract is completed.

1st. Amount of contract work on hand;

2d. Amount of labor and material installed on unfinished contracts;

3d. Amount of money billed on unfinished contracts;

4th. Amount of gross profit on finished contracts;

5th. Amount of actual profit on contracts.

The entries are necessary for any one to keep his cost up to the minute and not as most of us have done —leave it accumulate and unless in special instances—never total up.

When we secure a contract, we make a journal entry charging an account called "Work to be performed" and crediting a "Contract Account."

When materials go out, the cost is charged in total at the end of the month to an account called "Cost of Contracts" and credited to "Material Account." Of course, this means figuring cost of each material item, but if this is done, your material account tells you how much stock you have on hand continually, providing you charge material account with your purchases. I believe now that most of you depend on your yearly inventory to tell you what your stock is. We post cost of each material item to loose sheets headed Cost of Contract Sheets, having a separate sheet for each contract and the total of these sheets must correspond with "Cost of Contract" in the ledger. We do the same with labor—we have a "Labor Account" same as "Material" and this account tells how much is paid, while the "Cost of Contract" account is charged with what is paid. Each item is posted to the contract on which it applies. The total of the labor charged on these cost sheets must correspond with the total of what shows in the labor column of the "Cost of Contract." This is the part which must be kept up and you will see later when at the end of the month—the finished contracts are taken out from the unfinished contracts.

When the job is roughed in—we send a bill calling for 75 per cent of the contract—as a rule. We use one copy of the bill as a journal entry and the other is filed in the folder mentioned before when we first opened the contract. The journal entry is posted as follows: the Accounts Receivable account is charged and the "Work to be Performed" account is credited. As this "Work to be Performed" account now stands, it shows the amount not billed on contracts which are on the books.

At the end of the month, all finished contracts are handled together and the cost of each contract is charged to "Finished Contracts" and credited to "Cost of Contracts." We get the cost of each contract from our cost sheets which you will remember were to be posted each day. The result of this entry is that all the "cost of material and labor on contracts which are finished and which had been charged to "Cost of Contract" account are balanced and the account continues to show the amount of labor and material invested in unfinished contracts." This is the part that appears to me of much importance. How many of you, when you are asked by Bradstreets' or Dun's or your bank or your jobber for a statement of how your assets and liabilities stand, could swear to the amount of labor material invested in unfinished work and tell the amount billed against this investment without wanting a day or two to check up.

Another entry is made of the amount charged for a contract. This amount is charged to "Contract Account" and credited to "Finished Contracts."

The result of this entry is that all finished contracts are taken from what appears in "Contract Account" as live contracts, and this account shows now what total of work is actually under way—while the "Finished Contracts" show the total gross profit on all work finished, the cost having been charged and the amount secured being credited.

In writing the above explanation of the bookkeeping entries we make use of to get a true statement of our contracts, I do not give you any idea of the cost of keeping this work straight—yet every one of you will admit that you attempt to do the same thing in your own way. The method as outlined was given to us by a firm of accountants who installed in 1906 the system of tags and records we are using. We have made changes in several details but I have not found anything that will give us the results we want in any other manner. We go a great deal further than the above because we want to know our profit each month and we apportion our overhead expense to each job, using the labor on each job as the best basis on which to figure the expense burden, but I would not advise any of you to attempt to do this. Our business permits me to watch this end of the work and it certainly takes a large portion of expense to get what we get, but we would not change for all the money we have spent.

To show the advantage derived in having one of the firm on the inside all the time, we should say that during the month of February we did $789.40 worth of work on jobs between $10.00 and $50.00 on which we made 55 per cent on our selling price—or 123 per cent on our cost. We also know that on the last 200 contracts we did we charged $43,544. Our cost of labor, material and sundries was $27,325, and our percentage of profit on cost was 59.6 and on selling price 37.2. These results we get by close buying and watching our labor. We would sooner pay a superintendent a large salary and have every move of our $5.00-a-day men count, than pay two $5.00-a-day men to do in their own way what one man with intelligent superintending can do.

BELL ASKS TO BUY PASADENA HOME TELEPHONE.

The Pacific Telephone and Telegraph Company, under the provision of the new public utilities act, has applied to the California Railroad Commission to buy the Home Telephone and Telegraph Company of Pasadena. In the application the Pacific Company declares that it has options on 4,879½ of the total 5,190 of the Home Company shares at $44 per share, and that the total value of the Home plant is $730,0000. The Pacific Company declares that the presence of two companies in Pasadena subjects the people to annoyance and inconvenience and that the City Council suggested the purchase of the Home Company and is in favor of it.

WESTERN LAWS OF ELECTRICITY AND WATER

WATER RIGHT LEGISLATION.

New Mexico, North Dakota, Oklahoma, South Dakota and Oregon.

BY A. E. CHANDLER.

In accordance with resolutions adopted by the legislatures of Oregon and Washington in 1903 a commission was appointed by the governor of each state to draft a water code. As a result of a joint session of the two commissions with officials of the United States Reclamation Service, Mr. Morris Bien, supervising engineer of the Service in charge of land and legal matters, agreed to prepare a draft for the commissions. Mr. Bien's draft was widely circulated in order to receive the benefit of the criticism of many interested in the subject. The corrected draft is generally referred to as the "Bien Code," and although Mr. Bien aimed to take what he considered best from all the existing codes, most closely follows the 1903 Utah statute. It was not adopted in Oregon and Washington but was in North Dakota, Oklahoma and South Dakota in 1905 and in New Mexico in 1907.

Acquirement of rights. As provided in the 1903 Utah statute, applications must be made to the state engineer who, for stated causes, has the power of rejection. Notice of application is published and evidence of interested parties considered. In case of approval the state engineer fixes the time for completion of works and for application to beneficial use, not exceeding five years and four years additional respectively from date of approval. He has the power, for causes stated, to extend such times three years and two years respectively. Regarding the proof of completion of works and application to beneficial use the code follows Idaho.

Adjudication of rights. That part of the code dealing with the determination of water rights is restricted to five short sections. The state engineer makes "hydrographs, surveys and investigations of each stream system * * * obtaining and recording all available data for the determination, development and adjudication of the water supply of the state." Upon completion of survey, the state engineer delivers what data is deemed necessary to the attorney general who enters "suit on behalf of the state for the determination of all rights to the use of such water, in order that the amount of unappropriated water subject to disposition by the state under the terms of this act may become known."

In any suit over water rights all claimants must be made parties and when such suit is filed, the court shall direct the state engineer to make surveys and assemble the necessary data. The aim of the sections is to allow the state engineer to secure a determination of the rights on streams most used for irrigation and also to provide for a complete determination on those streams where suit is entered by private parties.

Distribution of Water. The distribution of water is cared for as in the states previously discussed. The state is divided by the legislature into three or more divisions along drainage lines. A commission is appointed for each division and the commissioners with the state engineer form the board of water commissioners. The state engineer divides each division into districts and the commissioner appoints a water master for each district.

Oregon.

As stated above, Oregon appointed a "water code commission" in 1903, but little was done at the 1905 session of the legislature beyond creating the office of state engineer. In 1907 a second commission recommended the "Bien Code" but it did not pass. In 1909, following the recommendation of a commission which had at its disposal the able assistance of Clarence T. Johnston, then State Engineer of Wyoming, a code was adopted which varies but little from that of Wyoming.

The state is divided into two water divisions with a division superintendent in charge. The two superintendents and the state engineer form the board of control. Contrary to the uniform practice elsewhere all three offices are elective instead of appointive.

The only striking departure from the Washington system is the procedure for defining rights. The sections in regard thereto are almost word for word the Wyoming sections up to and including the determination of rights by the board of control. Instead of considering such final unless appealed from, the Oregon statute provides that a certified copy of the determination and the original evidence shall be filed with the clerk of the circuit court which fixes a time for hearing the determination. The court after the necessary hearings either affirms or modifies the determination of the board.

A minor difference in the method of adjudication is that the determination in Oregon is initiated not by the board of its own motion but by petition of one or more water users upon the stream. As the board always has before it more petitions for determinations than it can act upon, it is clear that the change in procedure is of no practical importance.

The new legislation adopted in the western states prior to the 1909 statute in Oregon, is silent in regard to riparian rights, although such rights are recognized in Nebraska and the Dakotas. The Oregon statute, however, provides that the use of riparian proprietors shall be limited to the extent of the beneficial use prior to the passage of the act or, where works were under construction at the date of passage, to the amount of water applied to beneficial use in a reasonable time as fixed by the board of control. This part of the statute is of very doubtful validity as it is generally understood that the legislature is powerless to limit a vested right and the riparian right does not depend upon use.

Review of Legislation. In May, 1904, the state engineers of the eight states then having the office formed the Association of State Engineers. The first regular meeting was held at Boise, Idaho, in Sep-

tember, 1904. As a result of a close examination of the provisions of the various statutes it was then agreed that the only difference of importance was in the method of determining rights, and the same view is held today.

In Wyoming, Nebraska and Nevada rights are determined by a state engineer or engineering board, subject to review by the courts on appeal. The method has the advantage of freedom from embarrassing procedure as the officials collect the necessary field data and proofs and are so familiar with the essentials that the irrelevant is summarily eliminated. The rights are accordingly determined with comparative speed and at low cost.

In Colorado, Idaho, Utah, North Dakota, Oklahoma, South Dakota and New Mexico adjudications are made by the courts after the assembling of physical data by the state engineer—except in Colorado where the state engineer has no connection with the adjudication. The chief argument of the proponents of this legislation is that no other method is legally sound. It so happens, however, that the board or administrative method has been upheld by the supreme courts of Wyoming and Nebraska, and the court method has been held unconstitutional in Idaho—the only case in which it has been before the courts (again excepting Colorado).

The constitutionality of the Wyoming statute providing for the new system of defining rights was questioned in Farm Investment Company v. Carpenter (61 Pac. 266) decided May 26, 1900—after the statute had been in operation ten years. The Supreme Court in upholding the statute made the following pertinent statement regarding the efficiency of the two methods:

> As between an investigation in the courts and by the board, it would seem that an administrative board, with experience and peculiar knowledge along this particular line, can, in the first instance, solve the questions involved, with due regard for private and public interests, conduct the requisite investigation, and make the ascertainment of individual rights, with greater facility, at less expense to interested parties, and with a larger degree of satisfaction to all concerned.

In the same case it was contended that although the system might be valid for defining rights which had accrued subsequent to the adoption of the constitution, it was certainly invalid for defining rights accruing prior thereto and the Court answered:

> It follows from what has already been said that in this regard there exists no difference between claimants whose rights accrued prior to, and those acquiring rights after, the adoption of the constitution and the statute in question.

In Crawford v. Hathaway (93 N. W. 781) the validity of the Nebraska statute was atacked and the Supreme Court said:

> The Wyoming statute, from which ours is borrowed, has been subjected to judicial construction and is upheld by the Supreme Court of that State on the express ground that the powers authorized therein are not judicial, but administrative. * * * With this authoritative construction of the statute, and a decision of the very question raised in the case at bar upon reasoning quite convincing and satisfactory, it would seem that the question should be regarded as at rest. The primary object of the board is for the purpose of supervising the appropriation, distribution and diversion of water. This is obviously an administrative rather than a judcial function.

In Bear Lake v. Budge (75 Pac. 614) the Idaho Supreme Court held invalid that part of the 1903 statute providing for the initiation by a water commissioner of suits to determine water rights, in the following words:

> Said provision also violates the provision of our statutes which requires suits to be brought in the name of the real party in interest. The water commissioner, a public official, is not the real party in interest in a suit to quiet title or to determine adverse interest in property not claimed by or belonging to him or the state.

The new Oregon method is designed to meet the objections of those who contend that only a regular judicial tributnal should establish water rights. As stated above, the 1909 Oregon statute provides for an immediate affirmance or modification of the determination of the board by the circuit court. Regarding this feature Mr. Lewis, State Engineer of Oregon, in his third biennial report (1909-1910) states:

> It is doubtful if the requirement of a confirmation by the court strengthens the water code. On the other hand it is argued that this simply prolongs the proceeding unnecessarily and that the determination of the board, the members of which are supposed to have a special and technical knowledge of the conditions involved, should be final without the intervention of the court, except upon appeal. It is also argued that such appeal should only be allowed to the Supreme Court thus saving the delay occasioned by taking the matter first into the Circuit Court and then to the Supreme Court.

Acquirement of Rights. It has been stated that the following states have state engineers to whom applications on furnished printed forms must be made by intending appropriators: Wyoming, Nebraska, Idaho, Utah, Nevada, New Mexico, North Dakota, Oklahoma, South Dakota and Oregon. The state engineer of each of the above states will send an application blank and instructions on request and every intending appropriator should follow the directions carefully and rigidly and thus avoid later trouble. To the above list Colorado should be added as the state engineer there issues instructions regarding maps and statements to be filed within sixty days after the commencement of surveys or actual construction of any ditch or reservoir.

Texas requires the filing of a map and statement within 90 days after commencing construction, in the office of the county clerk of the county where headgate is situated.

The remaining western states, Arizona, California, Kansas, Montana and Washington still follow the crude practice of posting notices.

At the close of the first paper of this series an example of a California water notice, accepted by the Supreme Court, was given to show how little definite information need be stated in the notice to meet the requirement. The following form of notice has been used by the United States Reclamation Service in the states last mentioned and with slight changes and omissions can be adapted to any case.

Form of Notice of Water Appropriation.

.....claims at the point where this notice is posted, all the unappropriated waters of the ..... River, both surface and underflow, more specifically stated as amounting to ..... cubic feet per second*

This notice is posted on ..... 190...., on a..... tree on the ..... bank of the ..... River, in Sec. .....T.....R.....M., at a point distant.....

feet and bearing ..... from the..... corner of said section.

The water is to be used for irrigation, domestic, power, mechanical and other beneficial uses in and upon lands situated in ..... counties and located in the following townships .....

The water hereby appropriated is to be stored by means of a dam located in Ses.....T.....R..... in a reservoir located in Ts.....R.....and will be conducted to the points of intended use by means of canals, flumes, pipes, tunnels, or other appropriate means of conveying water, of the following dimensions and grade as will give capacity of ..... cubic feet per second.

*In California the amount should be stated in inches under four-inch pressure.

In Arizona the territorial laws (first state legislature now in session) require that a copy of the notice must be recorded in the office of the county recorder of the counties in which the ditch lies and also in the office of the Secretary of the Territory—no time limit is specified. In California and Kansas, a copy of the notice must be filed in the office of county recorder (county clerk in Kansas) of the county where posted in ten days and work must begin in 60 days. In Montana a verified copy must be filed in the office of county clerk of county where posted in 20 days and work must begin in 40 days. In Washington a copy of the notice must be filed in office of county auditor of county where posted in ten days and work on storage works must begin within three months and on diversion works within six months. In Montana, in case of appropriation from adjudicated streams, the new appropriator within 40 days after completion makes application to clerk of district court who orders an examination by a competent engineer. A hearing after published notice is held and the court limits the appropriation in accordance with its findings. The procedure was adopted in 1907. Montana has had a state engineer since 1903 but his duties are confined to operations under the Carey Act. In view of the simple procedure in regard to the acquirements of rights existing in other states having state engineers the Montana innovation is both inexplicable and inexcusable. Any logical procedure should precede construction and not follow it.

Aside from the information and warning regarding the amount of unappropriated water an intending appropriator receives in the states requiring applications to a state engineer, he is materially assisted by definitely knowing the time limit for construction and application to beneficial use. In the states allowing the posting of notices the statutes merely provide that the right shall relate back to the date of posting if the work is completed with reasonable diligence—to determine which, in case of conflict, means litigation.

Instances do not often arise where the state engineer is called upon to reject an application for the reason of probable detriment to the public welfare. As previously stated this authority was given to the state engineer by the 1903 Utah statute but was interfered with by the district court and was repealed in 1905. In the recent Oregon case of Cookinham v. Lewis (114 Pac. 88), decided Mar. 7, 1911, the provision of the Oregon 1909 statute authorizing the state engineer and board of control to reject an application where the proposed use is a "menace to the safety and welfare of the public" was upheld. It is noteworthy that Utah, which was originally characterized by centralized authority, should deny this power to a state official, and that Oregon, where the practice is so new and so foreign from that which preceded, should uphold it.

Water rights initiated by application to the state engineer are based upon beneficial use and perpetual unless abandoned or forfeited through nonuse—as was the case prior to the adoption of the new legislation. The only exception is the right for power purposes which has been limited in California (1911) and Oregon (1909) to a forty year term and on which an annual tax depending upon its magnitude is levied. The legislation regarding power rights will be considered in a later article dealing with rights of way over public land.

Conclusion. It should be emphasized in closing that the "new legislation" which has been discussed is dictated solely by good business sense. Instead of endless litigation regarding existing rights and no system worth considering regulating new appropriations, as in California, the new plan provides a full determination of existing rights in a single proceeding, the proper distribution of water by state officials according to such determination, and a complete control of the acquirement of new rights by a central office. It rests upon the same legal basis as the old and in no way attempts to interfere with or limit vested rights. It is applicable to any condition of topography or climate, as is illustrated by its acceptance by Nebraska in the east and Oregon in the west, by North Dakota in the north and New Mexico in the south. It leads the way from chaos and strife to order, harmony, and efficiency.

THE VELOCITY OF LIGHT USED TO SIMPLIFY VOLTAGE REGULATION COMPUTATION.

BY R. S. BROWN.

The exact calculation of voltage, current and power at the end of an alternating current transmission line can only be made by the use of the exact equations, deduced by the infinitesimal calculus, which treat the line constants, resistance, inductance and capacity, as uniformly distributed along the line. In these equations all the quantities concerned are vectors and the equations involve hyperbolic functions of the angle $\beta = \sqrt{ZY}$, expressed in radians. Their form is as follows:

$$e_g = e_r \cosh \beta + I_r Z \frac{\sinh \beta}{\beta}$$

$$I_g = I_r \cosh \beta + e_r Y \frac{\sinh \beta}{\beta}$$

Where,

e_g = Star voltage at generator.
e_r = Star voltage at receiver.
I_g = Star current at generator.
I_r = Star current at receiver.
Z = Total impedance per wire of line.
Y = Total admittance per wire of line.

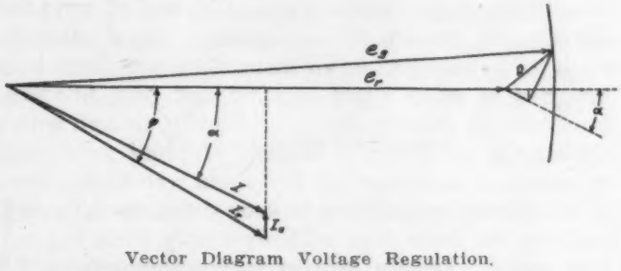
By the aid of tables of cosh β and sinh β, the application of these equations is not especially difficult, although it involves quite a bit of numerical work.

For the engineer, however, who is more accus-

tomed to dealing in powers of numbers than hyperbolic functions, the terms involving these functions may be expanded into a series containing powers of ZY and all the terms of these series beyond the first or second neglected as being of minor magnitude. By means of such an approximation the voltage equation becomes

$$e_g = e_r\left(1 + \frac{ZY}{2}\right) + Z\,1_r$$

This would be the exact equation for voltage if all the capacity of the line were collected into two equal lumps and one lump placed at each end of the line. This fact has given rise to the so-called "split capacity" treatment of the subject. Such approximation for lines not exceeding one hundred miles in length gives results close enough for most purposes, the error introduced in the voltage regulation thus found not exceeding 2 per cent. This approximation has the added advantage that if the power factor of the load be replaced by the power factor of the load combined with the condenser, which is assumed to be in parallel with it, the condenser may thenceforth be neglected entirely.



Vector Diagram Voltage Regulation.

The method of correcting the load power factor on this basis may be seen by referring to the accompanying diagram. The load component of I_r is $I_r \cos\phi$ and the wattless component, $I_r \sin\phi$.

$$I_g = \frac{1}{2} Y e_r = \frac{1}{2}\omega C e_r$$

$$\tan\alpha = \frac{I_r \sin\phi - \omega C e_r}{I_r \cos\phi}$$

$$\tan\alpha = \tan\phi - \frac{\omega C e_r}{2\, I_r \cos\phi}$$

But $P = \sqrt{3}\, E_r\, I_r \cos\phi$

Where $E_r = \sqrt{3}\, e_r$ = delta load voltage.

$$\text{Hence } \tan\alpha = \tan\phi - \frac{\omega C E_r^2}{2P} \quad \ldots\ldots (1)$$

The capacity, C, may be eliminated by means of the relation which holds between inductance and capacity of aerial circuits.

$$L C = \frac{l^2}{V^2} \text{ or } C = \frac{\omega l^2}{X V^2}$$

where V is the velocity of light, taken at 183,000 miles per second and l is the lengths of the line in miles. Applying this relation to equation (1) we get

$$\tan\alpha = \tan\phi - \frac{\omega^2 l^2 E_r^2}{2 V^2 X P} \quad \ldots\ldots (2)$$

For most purposes the use of vectors may be dispensed with entirely on the assumption that the locus of the voltage vector e_g is a vertical straight line instead of an arc. If the voltage regulation does not exceed 10 per cent and the angle made by D with e_r does not exceed 45 degrees the maximum error thus introduced will not exceed 4 per cent. This assumption gives

$$e_g = e_r + r\,I\cos\alpha + X\,I\sin\alpha$$

and the regulation will be

$$R = \frac{e_g - e_r}{e_r} = \frac{\sqrt{3}\, I \cos\alpha}{E_r}(r + X\tan\alpha)$$

or,

$$R = \frac{P}{E_r^2}(r + X\tan\alpha) \quad \ldots\ldots (3)$$

The percentage power loss will be,

$$S = \frac{3\, r\, I^2}{P} = \frac{P_r}{E_r^2 \cos^2\alpha} \quad \ldots\ldots (4)$$

The regulation, using ϕ in place of α, will be,

$$R_1 = \frac{P}{E_r^2}(r + X\tan\phi) \quad \ldots\ldots (5)$$

Subtracting (5) from (3)

$$R - R_1 = \frac{P}{E_r^2}(X\tan\alpha - X\tan\phi)$$

and from equation (2),

$$R = R_1 - \frac{\omega^2 l^2}{2 V^2}$$

for sixty cycles,

$$R = R_1 - .00000212\, l^2$$

That is to say, the voltage regulation of the line may be found by first finding the regulation neglecting capacity entirely by means of equation (5) and then correcting for capacity effect by subtracting $.00000212\, l^2$.

From this it is seen that the no load regulation of any line is approximately, for sixty cycles,

$$R_0 = -.00000212\, l^2$$

The results obtained by this method will not be in error by more than about 5 per cent for lines less than one hundred miles in length if the current at the load is not leading with respect to the load voltage.

Example: $P = 1000$ K.W., $E_r = 40000$ V., $\cos\phi = .85$, $\tan\phi = .62$, $l = 100$ miles, $X = 100$ ohms, $r = 80$ ohms.

Solution: From equation (5) neglecting capacity entirely, $R = .0935$. Correcting for capacity, $R = R_1 - .0212 = 7.23$ per cent. From equations (2) and (4), $S = 6.5$ per cent.

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POWER AND GAS

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CONTENTS

San Francisco High Pressure Water System..... 489
By Robert Sibley.

The Development of the Tangential Wheel..... 492
By Geo. J. Henry.

Errata Notice—The Rotary Air Compressor..... 496

Profit-Making in Electrical Contracting..... 496
By Louis Levy.

Bell Asks to Buy Pasadena Home Telephone..... 497

Water Right Legislation 498
By A. E. Chandler.

The Velocity of Light Used to Simplify Voltage Regulation Computation 500
By R. S. Brown.

Editorial 502
High Pressure Water Supply.
Regulation and the Golden Rule.

Personals 504

Meeting Notices 504

Los Angeles Electrical League 504

American Electric Railway Association Officials at Seattle.. 504

Trade Notes 505

New Catalogues 505

Industrial 506
Series Metallic Flame Arc Lamps.
Greenfielduct.
New A.C. Motor Starters and Speed Regulators.
Western Electric Business.
Electricity—The Servant in the House.

News Notes 508

High Pressure Water Supply

It is an attribute of a brave people who have successfully passed through a calamity which tried the souls of men that reference to the incident be shunned. Undoubtedly those who saw the soul-harrowing scenes accompanying the sinking of the Titanic, now that the first days of gasping and stunning are over, prefer not to allude to it again.

But the grim experiences of the past cannot be overlooked. The San Francisco fire,—like the sinking of the great unsinkable monster of the sea, the Titanic,—brought its lesson. In the memorable catastrophe of 1906 the rupturing of the city mains in some eleven separate points made it impossible to have relief from the on-rush of the devouring element. After studying all conditions attending the three days burning of the western metropolis, a committee of engineers recommended the installation of an auxiliary salt-water high-pressure system which, it is believed, will safely perform its protective function should the city ever again be visited with a disaster similar to that of 1906.

A building of steel arches, sufficient in strength to withstrand the tumbling across its roof of a modern sky-scraper, houses this equipment. Steel shutters, ready to be unrolled at an instant's notice, have been designed to make every window and door fire-proof from possible disaster without. Finally, though within the heart of the city, this isolated fireproof steel cage, by means of its sunken oil tanks and water containers, is maintained in readiness to keep the powerful pumps working for three days without supply from the outside world. Double sets of mains supplying a net work of interconnected pipes in the business district of San Francisco would seem to make the new city of steel and concrete as safe from fire as modern genius and enterprise of man could contrive.

The one distressing thing about the whole affair is, however, that this beautiful equipment, aggregating an outlay of $500,000, should not be put to some useful work during the years and years it may perforce be idle awaiting a possible recurrence of the disaster of 1906. It would seem that the engineers in charge should advise the installation of a steam turbine of sufficient capacity to meet the output of the boilers in the new station and thus grind out power for the Geary street road and other municipal undertakings. This turbine should have fireproof housing the same as the other equipment, for in time of great public disaster a supply of power in the days immediately following may not be entirely out of demand, as was shown to be true six years ago.

Regulation and the Golden Rule

Scarcely a city on the Coast has passed through the recent years without heated discussion upon regulation of corporations serving the municipality in the way of heat, light, power or water, and especially have those corporations engaged in telephony or electric traction been brought into the public lime-light of investigation. The campaign usually opens by a sublime indifference on the

part of corporate interests on the one hand pitted against the blood-thirsty agitator on the other. Not infrequently when the smoke of the first scrimmage clears away, the result turns out as it did in Los Angeles a year ago, in which a group of disinterested experts determined upon a fair and equitable rate, only to have the results of their labor arbitrarily cast aside by the city council and a rate of their own making instituted therefor. At present Portland seems to be engaged in a merry fight as to reduction in city street railway fares in which it is proposed to sell six fare tickets for twenty-five cents. The whole agitation, after all, should be an economic one, a discussion in which the highest dictates of justice and reason should predominate.

In this second stage of control in public utilities now with us, a saner, fuller realization of justice has come to all parties to the issue. The country over, big men—some representing the people, others the corporate interests—have come to look upon regulation in a new light and all have come to a fuller realization of responsibilities at issue. The principles of the golden rule are becoming more and more useful in solving these intricate problems.

If a modern Moses were to come to earth bearing tablets with chiseled commandments, it is not improbable that the ten dictates to the corporate interests would indelibly spell "**regulation,**" while those given to the public would have emblazoned in brilliant outline the motto of our forefathers, the "**golden rule.**"

In view of the discussion of prominent men representing all interests the following suggestions compiled from numerous views emphatically summarize the issue and the give-and-take to be maintained by both parties:

To the Utility Company

I.

Render good, adequate and continuous service.

II.

Establish fair and reasonable rate schedules.

III.

Give no discriminating rates to customers of the same class or between classes of customers for like service.

IV.

Urge upon your executives the necessity of a broad and liberal business administration.

V.

Let strict obedience to the law and no participation in politics be your motto.

VI.

Advance with the growth of the community, extend service into all populated sections of the municipality and suburbs and make an earnest endeavor to market the greatest possible volume of service.

VII.

Thoughtfully consider the march of invention and adopt approved types in machinery and apparatus, observing at all time a high standard of physical maintenance.

VIII.

Inculcate sound financial management throughout.

IX.

Observe a public spirited attitude in all matters concerning the general welfare and advancement of the community.

X.

Never break faith with the people in agreements, promises and announcements.

To the People

I.

Give to the public utility company the same degree of confidence, encouragement and respect that one business man may accord to another, that any citizen expects from his neighbor.

II.

Openly permit a fair profit on the capital, energy, ability and risks embodied in the undertaking and willingly permit a profit greater than mere interest that could be obtained without effort or hazard.

III.

Loathe attacks upon corporation management by popularity seeking agitators and demagogues.

IV.

Do not fail to recognize and reward improvements in service on the part of the public utility corporation.

V.

Earnestly recognize the fact that the operation of utilities differs fundamentally from merchandizing or manufacturing.

VI.

Never be unreasonable in demanding large capital outlay for improvements not strictly necessary to the rendering of adequate service, such as placing wires underground in cities of small or medium size.

VII.

Remember to pay your bills promptly, for the company cannot render the service demanded of it if its only source of income is retarded.

VIII.

Utilities must be protected against direct competition for all authorities agree that public utilities can be conducted with greatest benefit to the public as controlled monopolies.

IX.

Let legislation—municipal, state and national—be considered with the greatest care, and give a just recognition of the fact that, starting from a given base line, which varies in different localities, reductions in rates can be secured without financial loss only by increasing the volume of service sold.

X.

Encourage the utility company in attaining reasonable prosperity for new capital will never enter a dead field; treat all questions affecting public utilities in a fair-minded way, looking upon them as business question without regard to political considerations.

If now in addition both utility corporations and public alike follow toward each other the New Testament adage, "Love thy neighbor as thyself," worlds of good will continue to follow when both parties consider in their innermost whether or not the dictates of justice and equity impel their motives.

PERSONALS.

F. G. Baum, consulting engineer at San Francisco, left for a month's trip East this week.

A. E. Beck, who is interested in the electric street railway lines in Vancouver, is at San Francisco.

A. G. Jones, sales engineer with the General Electric Company, has returned to San Francisco from the East.

Albert Sechrist, a gas and electric supply dealer of Denver, is among the recent arrivals at San Francisco.

John M. Gardner, who has electric railway and lighting interests in Southern California, has been spending a few days at San Francisco.

E. A. Wagner, who is in charge of the transformer department of the Fort Wayne Electric Works, has returned to the factory after visiting California.

F. A. Cressey, who has electric lighting interests at Modesto, returned to California during the past week with an excursion party from the canal zone.

H. C. Goldrick, Pacific Coast representative of the Kellog Switchboard & Supply Company, spent the past week on a business tour of Northern California.

J. B. Mills, who is in charge of the Fort Wayne Electric Company's department of meter manufacture, has returned to Fort Wayne, Indiana, from California.

John S. Eastwood, engineer in charge of the construction of the Big Meadows dam for the Great Western Power Company, spent the past week in San Francisco.

W. D. Ward of the Pelton Water Wheel Company's sales corps has returned to San Francisco from Tahiti, where he closed the contract for a water-wheel installation.

J. W. White, manager of the Vix Engineering Company, who recently went to Chicago, will spend about a month in visiting the factories at Fort Wayne and elsewhere.

Frank Blossom, of the firm of Sanderson & Porter, of New York, spent the past two weeks in Arizona on business connected with properties owned or controlled by his firm.

J. J. O'Connell, who has been engineer in charge of the Pacific Power & Light Company's construction work at Tygh Valley, Oregon, has joined the engineering staff of the Electric Bond & Share Company at New York City.

James D. Mortimer, who has been vice-president of the Milwaukee Electric Railway & Light Company, Milwaukee, Wis., has been elected president of the company to succeed Mr. James Campbell, who has been elected chairman of the board of directors. Mr. Mortimer graduated from the college of mechanics at the University of California in 1900 and was at that time awarded the class medal as the most distinguished student of the year.

J. A. Roosevelt has resigned his position as master of transportation for the British Columbia Electric Railway Company, Ltd., at Vancouver, B. C. **Allan Purvis** has been appointed manager of the interurban lines of the company. The position of local managers of interurban divisions has been abolished. **W. H. Elson** has been appointed superintendent of two of the company's interurban divisions. **E. Sterling** will be in charge of the other two divisions. **J. B. Rannie** has been appointed traffic agent in charge of the company's system in Vancouver and suburbs.

J. W. E. Taylor, late of New York and Colorado, was recently appointed to take charge of the Big Bend extension of the Great Western Power Company. Mr. Taylor, who has had wide experience in construction of this kind, already has one hundred men at work at the Las Plumas plant. Two vertical generating units, with a maximum rating capacity of 25,000 kw. each, are to be installed in the plant when completed. Representatives of several of the leading water wheel manufacturers are expected at San Francisco before June 1st to confer with the Great Western management as to water wheel designs.

MEETING NOTICES.

The annual meeting of the Portland Section of the American Institute of Electrical Engineers was held in the Assembly Hall of the Eectric Building, Tuesday, May 21, 1912. H. E. Eisenmenger, of the National Electric Light Association, gave a talk on "The Theory and Space Representation of Electric Service Rates." To clearly show the space represenation of rates Mr. Eisenmenger exhibited a number of interesting models of rates of Western cities.

The Los Angeles Section of the American Institute of Electrical Engineers met at the Hotel Hollenbeck on May 21, 1912. J. E. Macdonald presented a paper on "Practical Joint Pole Construction."

AMERICAN ELECTRIC RAILWAY ASSOCIATION OFFICIALS AT SEATTLE.

The representatives of the American Electric Railway Association who are making a trip throughout the country, arrived at Seattle May 15, where they inspected the Puget Sound Traction, Light & Power Company. The main feature of the entertainment was a banquet given at the Rainier Club by Jacob Furth. An address of welcome was given by Mayor Cotterill and speeches made by President T. M. Carter, O. T. Crosby and C. G. Pierce of the Association. Those present, in addition to the visitors from the East, were Mayor Cotterill, Senator John L. Wilson, A. J. Blethen, Scott C. Bone, Councilman A. F. Haas, A. J. Goddard, J. G. Peirce, Max Wardall and Charles Marble, Superintendent of Public Utilities A. L. Valentine, Samuel H. Piles, J. D. Lowman, J. B. Howe, L. H. Bean, W. W. Wilshire, W. E. Best, E. G. Anderson, D. C. Barnes of Everett; G. P. James, M. Ramsdell, L. S. Winan, G. A. Richardson, George Carson, E. C. Gamnitz, A. D. Campbell, G. H. Richardson, H. T. Edgar, T. A. Shackleford of Tacoma, Joseph Schaefer, A. S. Michener, E. G. Shorrock, C. L. Francis, F. Dabney, L. R. Coffin of Bellingham, G. B. Harrington, E. A. Batwell, George James, W. J. Grambs.

STATE ELECTRICAL CONTRACTORS' NOTES.

The Turner Company have been awarded the wiring on an apartment house on the corner of Bush and Leavenworth streets.

W. S. Hanbridge, secretary of the California State Contractors, was in San Jose Tuesday arranging for the State Convention.

A. W. Bullard, vice-president and general manager of the Great Western Power Company, gave a dinner to the members of the Electrical Contractors' Association last Friday evening at Techau Tavern. This is the third of a series of dinners that have been inaugurated through the California State Association of Electrical Contractors in an effort to bring about closer relations between central stations and contractors.

Only one more week is left for the competitors to get their answers in to be able to win the contractors' schedule prize.

The Federal Electric Sign System now occupies a new store at 38 Fifth street. The Federal agency was formerly carried on by the late H. F. Frosch.

P. G. Jones, formerly of Hand & Jones, representing the Reliable Electric Company and the Automatic Electric Company, both of Chicago, is now located at 633 Howard street. He handles telephone specialties, principally made by the above companies.

PLANS FOR THE ENTERTAINMENT IN SOUTHERN CALIFORNIA OF THE BOSTON AND NEW YORK DELEGATES TO THE NATIONAL ELECTRIC LIGHT ASSOCIATION CONVENTION.

The De Luxe trains carrying these delegates will arrive from the Grand Canyon at Riverside at 7 a. m., Saturday, June 1st. After breakfast at Mission Inn, automobiles will be provided for rides to Rubidoux and Victoria Hill and incidentally delegates will be entertained at one of the great orange groves, where they will be allowed to pick oranges from the tree.

The party will return to the Mission Inn for lunch, after which they will be taken over a beautiful twenty-mile drive to Ontario, where they will visit the great plant of the Pacific Electric Heating Company, where light refreshments will be served. From there by automobile to Uplands, where their train will be found waiting for them, and thence to Los Angeles by way of Pasadena, arriving in Los Angeles at 5:05 p. m., and go direct to the Hotel Alexandria.

At 8 o'clock on the same evening, a reception will be tendered by the Los Angeles Chamber of Commerce, assisted by the Los Angeles Section of the American Institute of Electrical Engineers and the Architects' and Engineers' Association of California at the Chamber of Commerce Building.

On Sunday morning, the party will take special trains through Pasadena for Mount Lowe and Alpine Tavern, where a wonderful view of Southern California will be obtained and a good luncheon served. Returning, the party will stop at the Ostrich Farm and arrive in Los Angeles at 5 p. m.

On Monday, the party will take special electric cars via Hollywood, Sawtelle, Soldiers' Home, to Santa Monica, where a short stop will be made; thence to Venice, where another short stop will be made; thence via Playa Del Rey to Hermosa, where the plant of the Pacific Light and Power Corporation will be visited; thence to Redondo Beach; thence by way of Watts to Long Beach, where luncheon will be served at the Hotel Virginia at 12:30 p. m. After lunch take special cars to the Edison Company's new steam plant, where an hour will be spent. Then return by way of Wilmington to Los Angeles, arriving at 4:40 p. m.

The party will continue its journey to San Francisco by way of Santa Barbara and Del Monte on Tuesday, June 4th. The party will be the guest of the Los Angeles Gas and Electric Corporation, Pacific Electric Railway, Pacific Light and Power Corporation, and Southern California Edison Company.

LOS ANGELES ELECTRICAL LEAGUE.

The regular weekly luncheon of the Los Angeles Electrical League was held at the Hotel Hollenbeck, Tuesday, May 21. There was a large and enthusiastic attendance of members, the three invited guests being Franklin Booth, C. J. Balbour and E. B. Strong. T. E. Burger presided and called upon E. B. Strong to tell about the Golden Poppy Special train to the Seattle convention of the National Electric Light Association. One car has already been reserved from Los Angeles and there is a strong likelihood that another will be taken by the southern delegation. An address on "Commission Form of Government" was given by Mr. Lewis Works, one of the most interesting speakers by whom the League has been favored. Visitng electrical men are welcome at these meetings and invited to attend.

TRADE NOTES.

The Allis-Chalmers Company has sold to the American Falls Light & Power Company, at American Falls, Idaho, one 5500-h.p. Allis-Chalmers turbine water wheel. It will operate under a head of 45 ft., being direct-connected to a General Electric generator.

Chas. C. Moore & Company, engineers, have been awarded the contract for the immediate construction of a power and light plant for the C. H. Smith Lumber & Manufacturing Company of Marshfield, Ore., for the purpose of generating light and power for the operation of its plant.

The Allis-Chalmers Company has been awarded the contract for two 9000-h.p., spiral-case waterwheels for the Northwestern Electric Company. These wheels are to be direct connected to two 6000-k.v.a generators and installed in the Pacific Northwest to supply current for transmission to Portland, Ore.

The Northwestern Electric Company, which is preparing to install a hydroelectric plant at White Salmon, Wash., for the transmission of power to Portland, Oregon, recently opened an office at Room 805 California Pacific Building, 105 Montgomery street, San Francisco. Mortimer Fleishhacker is the managing director.

The business of the Crocker-Wheeler Company is increasing so rapidly on the Pacific Coast that J. E. Fries has been transferred to the San Francisco office as Pacific Coast engineer. With this addition to the present organization, prompter service than ever can be given to current inquiries. On April 1st, the company opened an office in the Title Insurance Building in Los Angeles, Cal.

The Westinghouse Electric and Manufacturing Company has sold to the Southern Pacific Company nine additional electric locomotives of the same type as the one sold several months ago for use on the Alameda County electric system. These 60-ton locomotives are the largest ever built for use with 1200-volt current and they are to be fitted with Westinghouse Type H. L. controllers. It is understood that four of the locomotives will be sent to Portland, one to San Jose, one to Los Angeles, and the remainder to Oakland.

The engineering department of the National Electric Lamp Association, which is sustained by certain works of the General Electric Company, will maintain an elaborate exhibit at the Electrical Show held in conjunction with the National Electric Light Association Convention at Seattle, Washington, June 10th to 13th. Booths 45, 46, 53 and 54, which are prominently located in the exhibit hall, have been reserved. The exhibit will consist of a complete line of National Quality Mazda incandescent lamps and some of the apparatus used by the engineering department in its testing laboratories. The main feature of the exhibit will be a large metal fixture, finished in statuary bronze, bearing six rows of branches from which various sizes of Mazda lamps fitted with reflectors are suspended. The fixture is about 10 feet in height and is surmounted by a 500-watt lamp. Mr. Ralph Beman, director of technical publicity of the engineering department, National Electric Lamp Association, will be in charge of the exhibit.

CENTRAL STATION PUBLICATIONS.

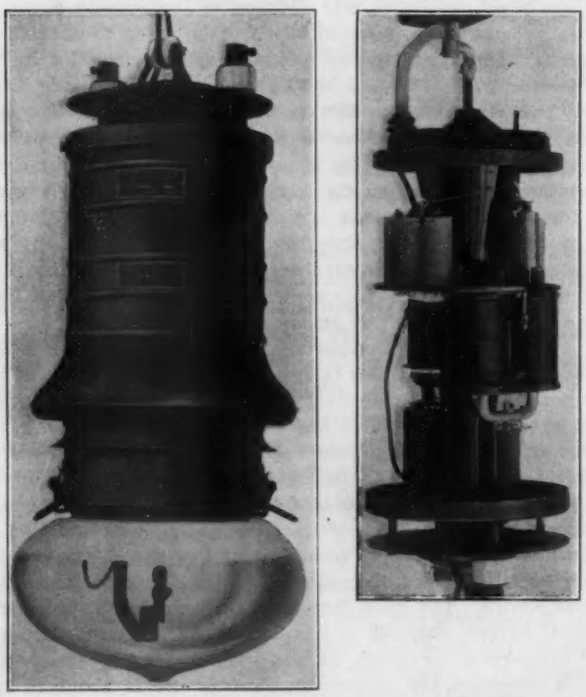
The Pacific Gas and Electric Company is distributing among consumers an attractive pocket pamphlet on "The Electric Meter, How to Read It, and Its Relation to Efficient Illumination."

"Edison Current Topics" from the Southern California Edison Company of Los Angeles, makes its initial monthly appearance with the May, 1912, issue. The first number contains several articles and many personal items which should be of great assistance in creating a closer co-operation and harmony among the employes of this great company and great credit is due to the progressive officials for its inception and to its able editor for its excellence. The leading article is a masterly contribution on "Public Regulation" by Geo. A. Damon. "With knowledge of the intelligence and vesratility and enthusiasm of Edison men, we predict for Edison Current Topics a bright and useful career" finds responsive affirmation.

INDUSTRIAL

SERIES METALLIC FLAME ARC LAMP.

The intense white light, resembling daylight, and the long life of electrodes and high efficiency, make metallic flame arc lamps particularly desirable for the lighting of streets, railroad yards, and other large areas, where series circuits are generally used because of the large saving in copper thus obtained. In the metallic flame arc lamps manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., the value of these desirable features is enhanced by the excellent distribution of the light, obtained by the clever allocation of the electrodes and reflectors. This is such as to produce uniform illumination; there is no intensely bright spot directly under the lamp, and no shadow rings. Most of the light is emitted at a wide angle, so that a large area is uniformly lighted.



Westinghouse Series Metallic Flame Arc Lamp.

The high efficiency of metallic flame lamps is due to the fact that not only the end of one electrode is luminous, as in the carbon arc, but the entire arc flame emits a bright light, owing to the presence of the volatile.

In the Westinghouse lamps the vapors produced by the metallic oxides, of which the electrodes are composed, are not permitted to come in contact with any solid substance in the lamp chamber, and therefore do not deposit as soot. The construction is such that air currents pass down over the inner surface of the globe and down along the electrodes, then out through a chimney. These air currents serve to carry off the vapors and soot, and also to steady the arc so that it does not run up the side of the upper (negative) electrode.

The negative electrode is on top, so that most of the light is thrown downward, as the brightest part of the flame is near the negative electrode. A reflector directs downward the small part of the light emitted above the horizontal, and the globe is so designed that reflections from it are in a downward direction. The lower electrode is stationary, and the upper electrode feeds, maintaining the arc always within half an inch of the same position.

The feeding mechanism is entirely free from floating parts, and is remarkably simple and rugged. When the lamp is out, the upper electrode is held away from the lower, and the cut-out contacts are closed. All magnets and electrical parts are of generous size, and easily removed. The starting resistors are wound on grooved spools, and are of special wire that does not become brittle or granular. The cut-out is extremely simple and reliable, and has carbon and copper contacts. A non-sticking dashpot with self-lubricating graphite plunger, damps the armature of the feeding magnet. The clutch is a hardened steel punching, similar to the clutch commonly used in carbon arc lamps.

The simplicity of the lamp contruction makes very few insulated parts necessary. Only solid mica and porcelain insulation are used. Each lamp is tested at 3000 volts alternating current for one minute before shipping.

The frame consists of heavy metal punchings, and is therefore practically unbreakable, yet light in weight. The main portion of the frame is formed by the chimney tube, hung from a heavy, punched cap, which carries the two terminal posts and the hanger.

A loop of non-corrosive metal, reinforced at the top, where wear is greatest, provides means of suspension. This loop encircles a porcelain insulator that is held in a punched sheet yoke with a heavy cotter pin.

Two-screw binding posts drilled for No. 4 wire are held securely in porcelain insulators, the square shanks of these posts preventing twisting.

The case is formed from heavy, black-finished copper. It is of the entirely removable slip type, and is secured in place with a three-point bayonet joint at the top. A knurled machine screw, inserted through the case near the top, and turned into a hole in the frame, effectively locks it in position. The case can be locked in any one of the three positions at which the bayonet joints will engage. When the case is taken off the entire lamp mechanism is exposed and rendered very accessible for inspection.

Two types of case are furnished for these lamps, one using a flat globe, which is used principally for the outside illumination of buildings, as it does not throw a shadow on the front of the building, and the other is used for ground illumination, as all light is thrown below the horizontal.

A mixture of metallic oxides forms the upper (negative) electrode, and the lower (positive) electrode is a composite metal button. The upper electrode is 16 inches long and approximately one-half inch in diameter. Both electrodes are changed at each trimming.

The positive electrode is held on a goose-neck casting, so arranged that it can be swung to one side when inserting the negative electrode. The negative electrode is held in a split bronze sleeve having a stem with a flexible conductor attached to its upper end. This holder slides in a guide tube, which protects the holder from fouling, due to deposit of the arc vapors, and is also arranged to prevent twisting.

All Westinghouse metallic flame arc lamps are adjusted, before shipping, for a seven-sixteenths inch arc length, which will ordinarily give an average terminal voltage of 68. Two different styles of each type can be furnished. One is adjusted for a current of 4 amperes and the other for 6.6 amperes. The same lamp cannot be adjusted for both currents. Two adjustments are provided, one for the length of the arc and the other for maintaining the voltage across the arc at its normal value. The length of arc is adjusted by means of a screw that permits the electrodes to be so spaced as to obtain a normal arc voltage. The shunt cut-out adjustment limits the voltage of the lamp to a predetermined maximum.

GREENFIELDUCT.

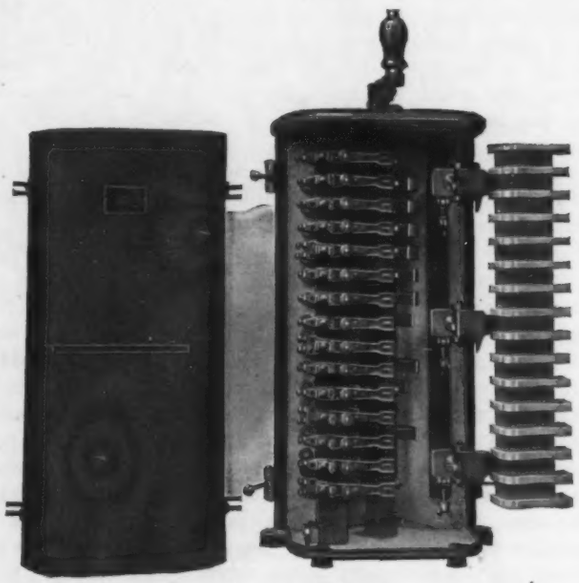
The Sprague Electric Works of General Electric Company, New York City, has recently placed on the market a Rigid Iron Conduit known to the trade as Greenfielduct. It is claimed by the manufacturer that Greenfielduct possesses advantages over all other types of rigid iron pipe, due to the fact that it is treated with hot galvanizing on both the interior and exterior surfaces, the process being such as to afford a standard sulphate of copper dip test equivalent to seven or more dips.

Greenfielduct.

The reputation which Greenfield B cable has achieved is due largely to the treatment of the steel armor with molten zinc, and as BX cable has been found to wear unimpaired under conditions which might otherwise have resulted in rusting of the armor, there is every reason to conclude that Greenfielduct, having a similar hot galvanized finish, will prove equally serviceable.

NEW A. C. MOTOR STARTERS AND SPEED REGULATORS.

The accompanying illustration shows the general construction of a new line of starters and speed regulators for a.c. slip-ring induction motors, built by The Cutler-Hammer Manufacturing Company, of Milwaukee. As will be noted, the drum is similar in appearance to the d.c drum controllers brought out last year. The same kind of non-stubbing, straight-line contact fingers are used. An arc-proof shield is mounted under the finger board, and so slotted as to interlace with the deflectors, preventing burning of the board and communication of arc from one finger to another. The operation is with an easy and smooth rotary motion. With the starter the resistance is entirely cut out of the rotor circuit when running normal, while with the speed regulator the operating handle may be moved backward or forward, according to the variation in speed desired. Standard regulators are arranged to give 50 per cent speed reduction. The resistance used with these controllers varies according to the duty—whether for starting only or for regulating. The cast metal grids are mounted in special mill-end frames on two supporting rods. These rods are covered with mica tubing and are also insulated from the end frame by fibre washers and tubes.



Cutler-Hammer A.C. Motor Starter and Speed Regulator.

WESTERN ELECTRIC'S BUSINESS.

Total of goods billed out during April by the Western Electric Company shows the surprising increase of 17 per cent over the total for April, 1911. Last month's gain slightly more than offset the falling off shown by the first two months of this calendar year. March ran about even with the preceding March, so that the first four months of 1912 are about 1½ per cent ahead of the same four months in 1911.

April's gain is looked upon by the company's officials as somewhat extra-normal and due to several special conditions. It indicates an increase in the year's total business which later months, it is believed, will not sustain. Those close to the company say that if 1912 shows as good business as last year, when sales totaled $66,000,000, they will be well satisfied with the result.

The gain last month came chiefly from the East and the West sections of the country. The Middle West was somewhat behind, reflecting the cold weather and late spring. Later it is expected that the Middle West will make the lost ground, provided crop developments continue satisfactory.

This is the busy season of the year for the Western Electric Company. The telephone, electric light and power companies are overhauling their plants and going ahead with extensions and improvements. The months of April, May and June usually see the largest volume of goods billed. Foreign business was also an important contributing factor to the April improvement.

Western Electric is contemplating no construction work of importance. The Hawthorne plants are completed and the company has sufficient facilities to care for the present volume of trade and considerable in addition. Number of employes continues about the same as a month ago.

Reports from the company's salesmen throughout the country are generally optimistic. No great expansion in the electrical industry seems at hand, but that it is not falling behind is indicated by the Western Electric's returns for the year to date.—Taken from May 14th issue of Wall Street Journal, New York City.

ELECTRICITY—THE SERVANT IN THE HOUSE.

A great deal has been said and written about the electrical home of the future; but it has remained for the Western Electric Company to point out, in their recently published booklet, entitled, "Western Electric Household Helps," that the electrical home is a thing of the present.

The booklet is a most attractive one and, being dedicated to the American woman, it has been the aim to produce something which would appeal to the housewife by virtue of its delicate appearance and engagingly written subject matter. The finished publication is evidence that this aim has been achieved. The booklet shows conclusively that with electricity in the home, the much-dreaded housework and house cleaning may be shorn of their terrors. Such devices as electric irons, electric toasters, chafing dishes and percolators, electric warming pads, electrically operated vacuum cleaners and washing machines and electric motors for sewing machines, make life infinitely easier for the modern housewife. For beautifying the home, there are Sunbeam Mazda Lamps and Mazdaliers and portable lamps; for saving stairs, there are inter-phones, and for keeping the house cool, fans.

NEWS NOTES

INCORPORATIONS.

SAN DIEGO, CAL.—Articles of incorporation have been filed of the Monarch Meter Company. The company proposes to manufacture gas appurtenances and accessories. It is capitalized at $50,000. Of this sum $26,000 has been subscribed.

LORDSBURGH, N. M.—Articles of incorporation have been filed for the Lordsburg Water, Ice and Electric Company. Principal place of business shall be in or near Lordsburg. Capital stock $50,000. The incorporators are: R. E. Cameron, M. M. Crocker, W. H. Small

SAN BERNARDINO, CAL.—For the purpose of creating a bonded indebtedness of $750,000, the Fontana Water Company has filed articles of incorporation. The bond issue is created to carry on further development of the tract owned by the company in the Rialto district.

LAS VEGAS, N. M.—The Mica Corporation, a company that expects to do a general telephone, telegraph, water rights, lighting and real estate business, with offices at Tres Piedras, Rio Arriba County, has been incorporated with a capital of $3000, by E. C. Osborn of Tres Piedras, A. L. Osborn and M. A. Calhoun of Denver.

SALEM, ORE.—Articles of incorporation have been filed by the Donald Water Company, of which A. E. Aufrance, A. Aufrance, and B. S. Quinn are the incorporators. The location is at Donald, on the Oregon Electric. The purpose is to lay and construct water pipes for serving water to consumers and to buy, subdivide and colonize lands.

TRANSMISSION.

CENTRALIA, WASH.—Excavating for the new electric light plant at Tono, an appropriation for which was recently made by the Washington Union Coal Company, has been started.

CLARKSTON, WASH.—The Lewiston-Clarkston Improvement Company has awarded the contract for the construction of the substation of the company's electric light system to J. C. Lasker, of Lewiston. The improvement will represent an expenditure of $20,000.

SPOKANE, WASH.—The International Power & Manufacturing Company plans to begin construction work this summer on a plant on the Pend Oreille River, in the northeastern part of Washington, designed to develop 100,000 horsepower, according to Wilbur S. Yearsley of Spokane, who, with M. H. Gerry of Helena, Mont., represents the concern.

SAN FRANCISCO, CAL.—The Indian Valley Light & Power Company, operating principally in Seneca, Greenville, Crescent Mills, Taylorsvile and Keddie, has applied to the railroad commission for authorization to issue $145,000 of new stock, of which $125,000 will be common, and $20,000 preferred. The revenue thus derived will be used to enlarge the company's facilities on the north fork of the Feather River.

VISALIA, CAL.—The Mt. Whitney Power Company has begun the construction of a new substation at Lindsay, which, when completed, will cost the company $50,000. Although the present substation has a capacity of 3000 horsepower, and was constructed a few years ago with the prospect of a great demand for "juice" in view, it has been found inadequate to supply the demand for power in the community. With a capacity of 10,000 horsepower, the new substation will be the main switching plant of the Mt. Whitney system. Work on the new structure will be rushed, and the entire building will be completed within a few months.

AMERICAN FALLS, IDAHO.—A contract has been let to Jas. A. Green Company for the construction of a power plant here for James A. Brady and associates in the American Falls Power Company. Only one unit of 5000 h.p. will be erected now, but the plant is designed to furnish 35,000 h.p. ultimately. Green's contract price is $250,000. Power and light will be furnished Pocatello and other points in southwestern Idaho.

LOS ANGELES, CAL.—At a joint conference between the Public Utilities Board and the Board of Public Works, to consider the subject of recommending an ordinance providing that steel poles shall be used in the downtown district for the purpose of carrying trolley and feed wires, it was decided that the existing arrangement is preferable to one that would cause the placing of more poles on the streets and the two boards will send to the council recommendations that the proposed plan be not adopted.

REDLANDS, CAL.—Application has been made to the State Railroad Commission by the Holton Power Company of Redlands to issue $300,000 of first and refunding mortgage gold bonds. The company does a light, power and ice business in the Imperial Valley, and wants the money to discharge current liabilities incurred in construction and for additions and improvements. The present authorized capital is $1,500,000, of which $1,250,000 is outstanding in common stock. First mortgage bonds to the extent of $500,000 are outstanding.

GILROY, CAL.—The State Railroad Commission has granted the Sierra & San Francisco Power Company a certificate of public convenience and necessity to exercise its franchise rights in the towns of Gilroy and Morgan Hill and the county of San Benito for the transmission of electric power lines. The grant was made, however, with the understanding that the power company could run its lines through the county and towns only for the purpose of extending them to Salinas or Monterey. The company will not be permitted to distribute or sell power in either Gilroy or Morgan Hill. Gilroy recently sold its municipal plant to a private corporation, which now serves the territory, apparently, according to the Commission, satisfactorily.

SPOKANE, WASH.—Thompson Falls Development Company, headed by J. A. Coram of Boston, and backed by New England capital, has completed plans, involving the expenditure of several million dollars, for power development at Thompson Falls, Mont., to supply electricity for irrigating plants in the Spokane valley and for manufacturing in Spokane, Wash., and a dozen cities in northern Idaho and western Montana, also the mines in the Coeur d'Alene district. The plant, which will be one of the largest in the world, is to be in operation within two years. The company has acquired all the necessary water rights on the Clarks Fork of the Columbia River. George H. Potter, engineer in charge, and a large force of men are at work on the preliminaries of the big dam, which is designed to harness the power at Thompson Falls. The company also has a right-of-way from the plant to Spokane, 90 miles.

ILLUMINATION.

SAN FERNANDO, CAL.—The Southern California Gas Company has applied for the sale of a franchise for a local gas system.

VISALIA, CAL.—The Central California Gas Company was the only bidder for a gas company franchise and the franchise was awarded. Lindsay will be the headquarters of

the new company. A pipe line will be taken to Porterville after the Lindsay plant has been completed.

HOOD RIVER, ORE.—It is reported that the Hydroelectric Light Company will soon begin its work of extending its line from Hood River to The Dalles. The distance is 24 miles.

BISHOP, CAL.—Application has been made by the Southern Sierra Power Company asking for a franchise and the privilege to construct and maintain an electric pole and power line throughout the county for a period of 50 years. A resolution was adopted that the franchise be advertised for sale and the board take final action on June 2, 1912.

BANNING, CAL.—Announcement of a resumption of activity here has been made by the Consolidated Reservoir & Power Company of Los Angeles. This concern is capitalized at $1,000,000 for the purpose of diverting the Whitewater River from its desert course to the better lands of the Banning Valley, where the water will be used in growing apples and in generating electricity.

ROSEVILLE, CAL.—Contracts for the electric distributing plant, incandescent lamps and for supplying the power have been awarded. The Great Western Power Company secured the contract for installing the distributing plant, the price to be $11,400. This company also secured the contract to furnish the power for lights at 1 cent per kilowatt. The contract for furnishing the 60 candle power lamps was given to the Pacific Gas & Electric Company for 83 cents a lamp. The Wagner Company secured the contract to install the transformers.

SAN FRANCISCO, CAL.—The Coast Valleys Gas & Electric Company has authorized a bond issue of $10,000,000, and issued $786,000 of them, bearing 6 per cent interest, just before the public utilities act became operative on March 23 last. Saturday the company requested that it be permitted to change a clause in the contract under which the bonds were issued. It is desired to wipe out a statement made in the contract that the company will assume all taxation on the bonds. They are tax-exempt in this State, but if sold to residents of States which do not exempt them from taxation the company would have to bear the tax burden, under the present contract. The Commission has the request under consideration.

TELEPHONE AND TELEGRAPH.

SOUTH PASADENA, CAL.—The Home Telephone Company proposes to establish an exchange in South Pasadena. A committee will confer with the company.

SAN BERNARDINO, CAL.—The work of stringing a telephone line from Lone Pine to this city will be completed by the end of the week and telephonic communication between Inyo and San Bernardino counties will begin.

LEAVENWORTH, WASH.—Work on the telephone line to connect with the Tumwater Light & Water Company's line from the summit of Beaver Creek to the head of the Lake Wenatchee will begin within a few days. It is to be constructed by the Forestry Department and work will be in charge of Forest Supervisor Sylvester.

SAN FRANCISCO, CAL.—The Third District Court of Appeals has heard the application of the California Telephone & Light Company vs. Frank C. Jordan, Secretary of State, to compel the Secretary of State to file its amended articles of incorporation. Jordan refused to file the amended articles on the ground that the law was not complied with in that the articles, as amended, did not contain the copies of the notary's certificate. The case was submitted on briefs and will be decided later by the Court.

LOS ANGELES, CAL.—Thomas Foulkes, president of the Board of Public Utilities has proposed that the position of telephone tester be created for the purpose of having a city official to investigate the many complaints of telephone service. He proposes that when a complaint is made against telephone service, the complainant must deposit $1. If the test proves that the phone is in error, the company must pay that amount, but, if the complaint is unjustly made, the complainant must forfeit the money deposited. By this means, Foulkes believes many unjust complaints will be eliminated and just ones will be rectified.

TRANSPORTATION.

OAKLAND, CAL.—A franchise has been granted to the San Francisco-Oakland Terminal Railway for an extension of its line north on Euclid avenue, Berkeley.

JUNCTION CITY, ORE.—Work is being rushed on the most difficult stretch of construction of the Oregon Electric Railway, between Junction City and Harrisburg, where the road will cross the Willamette River.

MILWAUKIE, ORE.—The City Council granted the Southern Pacific Railway Company the right to construct an electric line, telephone and telegraph lines through Milwaukie along the route of the present track.

SAN DIEGO, CAL.—The San Diego Electric Railroad Company plans to expend $100,000 for heavier weight rails to be put down in down town streets, on Fifth from Ash to the bay, University avenue and the rest on Fifth street.

SAN JOSE, CAL.—The San Jose Terminal Railway Company, by its vice-president, John A. Mehlin, has filed a petition for a franchise to construct and operate a standard gauge single or double track railroad within the city.

VALLEJO, CAL.—The Vallejo & Northern Railroad has started reclaiming 23 acres of land north of this city, which will be used for warehouses and shops. The tracks for the Vallejo & Northern are to be laid along the water front to Main street, where its terminal and depot will be. Hard Bros. are the contractors.

SAN FRANCISCO, CAL.—California is to become a bondholder in the municipally owned Geary street electric line. This announcement was made in a communication sent to Mayor James Rolph Jr. by the State Board of Control, informing the Mayor that the State is ready to subscribe for any amount of the new road bonds up to $100,000 that remain untaken.

SEATTLE, WASH.—The Seattle, Renton & Southern Railway, an electric interurban line, has been adjudged bankrupt by United States District Judge Cornelius H. Hanford, and E. M. Mills and O. D. Collins have been appointed receivers. The receivership was allowed on a complaint made by members of Peabody, Houghtelling & Company, of Chicago, a leading creditor.

SACRAMENTO, CAL.—By July 1, the Sacramento-Woodland Electric Railroad will be completed and the Northern Electric will be operating trains over the route. The Northern Electric has an agreement with the Sacramento-Woodland to operate the line until the Vallejo Northern is in a position to take it over as a part of the completed system west of Sacramento. The Sacramento-Woodland's tracks connect with those of the Northern Electric at the capital city.

SACRAMENTO, CAL.—Electric railways operating within the State and whose officers have labored under the belief that it is necessary to obtain a certificate of public convenience and necessity before proceeding with any interurban

extensions are absolved from any applications, according to an informal decision rendered by the State Railroad Commission. The Sacramento Valley Electric Railroad, proposing the construction of a line from Red Bluff in Tehama County, to Dixon, in Solano County, filed an application for a permit to begin work with the Commission, but the application was returned as unnecessary. The Commission holds that under the utility law it has jurisdiction in this respect only over street railways and not interurban roads.

SAN FRANCISCO, CAL.—Bids for supplying the city with electric power for the Geary street road have been opened, the lowest being that of the Pacific Gas & Electric Company at 1c per kw. hour for direct current and .0085 for alternating current. The board took the bids under advisement. Should the Supervisors decide that it is cheaper to buy power for the municipal road than it is to build powerhouses and generate its own electricity, the contract to the lowest responsible bidder probably will be awarded. The other bids received were as follows: Sierra-San Francisco Power Company: Direct current .014, alternating .009; Great Western Power Company .024 and .011. The United Railroads proposed some time ago to supply the city with power for the Geary street road, but from the bids received the Sierra company, which supplies the United Railroads, has been outbid by the Pacific Gas & Electric Company.

WATERWORKS.

TUCSON, ARIZ.—The Pinal Mutual Irrigation Company will commence a canal about June 1st.

LOS ANGELES, CAL.—The California-Michigan Land & Water Company has been granted a franchise for a water system in a portion of Los Angeles County.

WAPATO, WASH.—The Council has accepted the bid of the Payne Construction Company of Tacoma for $8290 for the construction of the distributing system of a water works plant.

REDLANDS, CAL.—A special election will be held May 28th to vote on the question of issuing bonds in the sum of $600,000 for the acquisition and construction by said city of a complete waterworks system. The said bonds will bear 5 per cent interest, payable semi-annually.

LOS ANGELES, CAL.—The City Council has instructed the public service commission to enter negotiations with the San Pedro Water Company with a view to purchasing the plant of that company, and serving San Pedro and Wilmington with an adequate supply of domestic water.

SALEM, ORE.—A. Eugene Aufrance, A. Aufrance and B. S. Quinn have been granted the right to lay down water pipes and mains in the town of Donald, 23 miles north of Salem. The company will begin as soon as practicable to construct a water system for that progressive city.

OAKLAND, CAL.—The City Council has awarded to William Heafey, on his bid of $11,465.35, the contract for the extension of the high-pressure salt-water system from Washington to Market street on 14th street. There were three bids received. The work will commence within 30 days.

COVINA, CAL.—The city is preparing to take over the local domestic water plant, and engineers are now figuring on the physical valuation of Covina Domestic Water Company. At a special meeting the trustees started the first action to determine what reservoirs, pipe lines and other properties of the company are worth.

SPOKANE, WASH.—One of the largest power plants in the world will be built at Thompson Falls, Mont., to supply electrical current for the irrigation of the Spokane Valley and for the development of manufacturing in the city of Spokane. J. A. Coran, the Boston capitalist, and his associates are back of the project.

SAN FRANCISCO, CAL.—California leads all other districts in the amount of water power developed under permit from the Government, according to a report received at the forest service of this city. Of the aggregate 1,383,066 horsepower, which is comprised in 165 plants, 62 plants, developing 1,026,436 horsepower, are located in California.

LOS ANGELES, CAL.—Frank G. Henderson, president of the water board, proposes the presentation of a report to the City Council outlining a complete system of water distribution; an equitable system of paying for service. Completion of the system, costing $5,000,000 or $6,000,000 by January 1, in preparation for the completion of the aqueduct.

PASCO, WASH.—The City Council rejected all bids received for the installation of the irrigation system in the two local improvement districts, on the grounds that the specifications had not been complied with. Bids will be readvertised and called for May 28th. Jordan & Wright of Ellensburg were the lowest bidders, their figures being $30,740,80 for district 43 and $18,270.85 for district 44.

SAN FRANCISCO, CAL.—Plans are completed and specifications are being written for the construction of a brick addition to the pumping station at the Presidio. Separate bids will be taken on the general construction, lighting fixtures and plumbing. The exterior of the building will be faced with repressed red brick, the roof will be of slate. Plans will be ready for figures within a week or ten days for a water-distributing system and public latrines in the National Cemetery at the Presidio of San Francisco. The water system will include 700 feet of from 1½ to 3-inch galvanized iron, some 4-inch cast iron pipes and garden hose cocks.

PORTLAND, ORE.—R. B. Metcalf, of 955 Patton avenue, who, it is understood, represents a group of Eastern capitalists, has filed application with the State Land Office of Washington, at Olympia, for the right to overflow with water, permanently, public lands for 95 miles bordering on the Cowlitz and Kalama rivers. The petition sets forth that the applicant expects to install a huge water plant. It is understood that hydro-electric engineers who have investigated the situation have reported that there is opportunity for the harnessing of more water power on the property involved in this application than has been or ever could be developed on the entire length of the Clackamas River which now furnishes Portland with all its industrial and commercial electrical energy.

OAKLAND, CAL.—The water rates committee of the Supervisors has heard arguments from the representatives of the Spring Valley Company, with the intention to show that the present rates are too low to permit the company to retain an adequate return on their expenditure. That the company hoped to increase the amount of water delivered by them to 50,000,000 gallons a day in another year, and that it would be willing to take a contract to deliver 125,000,000 a day in four years, was the statement of W. B. Bourn, president of the corporation. Bourn declared that the company proposed to protect the water supply of every one of its consumers, and that with a reasonable rate it could undertake to supply from the outside all the water desired. Chairman Andrew Gallagher of the committee said that the refusals of the company to supply water were not in accord with good public spirit, and that the conduct of employes of the company in cutting house connections and pressing the payment of bills unreasonably were largely responsible for the bitter feeling against the company. Bourn said that to give the consumer the benefit of the doubt in a disagreement over a bill was a standing rule of the company. Bourn urged an allowance for depreciation, and asked for an appraisal of the company's property, stating that no such estimate had been made since 1901.